JANUARY 12, 1951.

THE ENGINEER

A Seven-Day Journal

The National Traffic Census

DURING one week of August, 1950, the Ministry of Transport conducted a pilot census to discover what variations had occurred since 1938 in the traffic flow in urban, industrial and rural areas of this country. Although the completion of the analysis of this census will take some time, the Ministry has published this week some interesting facts which have been revealed. The census covered 266 points, seventy-three of them on trunk roads, 117 on Class I roads, and seventy-five on Class II roads. Every vehicle passing a census point between 6 a.m. and 10 p.m. was counted, and motor-cycles, motor-cars, omnibuses, goods vehicles, horse-drawn vehicles and pedal-cycles were enumerated separately. The overall increase, since 1938, in the average daily volume of traffic, based on all the census points, was 7 per cent. On the trunk and Class I roads it was 6 per cent and on Class II roads 12 per cent. Comparing the two years, 1938 and 1950, the Ministry says that on trunk and Class I roads horse-drawn traffic decreased by 71 per cent, pedal-cycles by 35 per cent, all passenger vehicles by 6 per cent, and motor-cars and taxis separately by 11 per cent. But motor-cycle traffic increased by 16 per cent, omnibuses and coaches by 34 per cent and goods vehicles by 59 per cent. The overall increase in all mechanically propelled vehicles was 6 per cent. Another observation made by the Ministry is that, although in 1950 traffic as a whole was slightly more than in 1938, the variation from point to point was very much greater. Of the 190 points on trunk and Class I roads, 133 showed increases in the volume of traffic, while the remainder showed decreases. Increases were recorded at 122 points in England and Wales and at eleven points in Scotland. In the predominantly agricultural eastern counties of England twenty of the twenty-three census points showed increases, as did twenty-three of the thirty-eight points in the industrial north.

Railway Appointments

IT has been announced by the Railway Executive that Mr. J. Taylor Thompson, civil engineer, North Eastern Region, is to succeed Mr. J. Briggs as civil engineer, London Midland Region, on April 30th next, and Mr. F. E. Campion, assistant civil engineer, Southern Region, is to succeed Mr. V. A. M. Robertson as civil engineer when he retires on March 31st next. Mr. Taylor Thompson has been in charge of the civil engineering department at York since 1942 and prior to that he was assistant engineer for five years, having come to York from Darlington, where he was district engineer. He was Chairman of the Yorkshire Association of the Institution of Civil Engineers in 1939–40 and on two occasions was awarded the Trevethick Premium of the Institution—for papers on high speed track and on the lay-out of locomotive depots. During 1948 and 1949 he was president of the Permanent Way Institution. Mr. Taylor Thompson was Chairman of the committee which, in 1948, prepared the designs of the new flat bottom rail track now adopted as standard for British Railways and he has represented the railways on a number of British Standards Institution Committees. Mr. F. E. Campion began his career in 1912 with the Great Northern Railway (Ireland) and during 1914–15 he held a commission in the Royal Engineers (Special Reserve), and in 1916 was appointed as an assistant on the G.N.R. (Ireland). He joined the L.B.S.C.R. in 1920 and in 1921 he was transferred to East Croydon as assistant district engineer. He was appointed assistant divisional engineer, London East, Southern Railway, in 1923, and was transferred to head office in 1927. In 1930 he became assistant for special works; in 1933 assistant to the chief engineer; in 1935 divisional engineer, London East; in 1940 divisional engineer, London West; and in 1946 maintenance engineer. Upon nationalisation of the railways in January, 1948, Mr. Campion was appointed assistant civil engineer of the Southern Region.

Crude Oil from Arabia

THE first shipment of crude oil from Arabia to this country has arrived at the Anglo American Oil Company's refinery at Fawley, in the tanker "Apache Canyon." This oil was delivered to the Mediterranean for transhipment by tanker, through the Trans-Arabian Pipe Line Company's new pipe-line, which stretches for over 1000 miles to the Persian Gulf. This new pipe-line, "Tapline," as it is called, starts in the Abquaiq oilfield of Saudi Arabia. A line to the Arabian-American Oil Company's refinery at Ras Tanura branches off the main line from Abquaiq and from there the main line extends 1067 miles across the desert until it reaches a point 4 miles south of Sidon, in the Lebanon. Built at a cost of 200 million dollars, the pipe-line will make available large quantities of crude oil on the eastern shore of the Mediterranean, and it will save the work of a fleet of sixty-five tankers. Moreover, the 3500 miles sea journey around the Arabian peninsula, up the Red Sea and through the Suez Canal, is eliminated. The present capacity of the pipe-line is 300,000 barrels a day and its annual throughput will reach 110 million barrels, or approximately 15 million tons—an amount nearly equal to what will be the whole of the refinery throughput of crude oil in the United Kingdom in 1952. The line, which took nearly three years to build, is 30in and 31in in diameter. Two sizes of pipe were used to save space in transport by nesting the smaller into the larger lengths of pipe. A new port, Ras el Misha'ab, was built on the Persian Gulf to receive the cargoes of pipes, and special trucks and trailers were built to carry them across the desert. The first pipe arrived on site in December, 1947, and oil began to flow in the line towards the middle of 1950. It took almost 5 million barrels of oil to fill the pipe and on December 2, 1950, the line and storage tanks at Sidon were full, ready for despatch of crude oil to this country to begin.

Report on the Derailment at Tollerton

THE report has now been issued on the inquiry into the derailment which occurred on June 5, 1950, near Tollerton, on the North Eastern Region of British Railways. Tollerton is between Darlington and York and the train concerned was the 12.15 p.m. express passenger train from Newcastle to York. When this train was travelling at some 45 miles an hour, about half-a-mile south of Tollerton, the engine and four coaches were derailed. The track at this point had buckled under another express passenger train travelling at about 65 miles an hour some 15 minutes earlier. This first train, although it was damaged, was, fortunately, not derailed. In the accident, nine passengers and the driver and fireman of the 12.15 express were injured. Colonel D. McMullen, an inspecting officer of railways, states in his conclusions to the report that the derailment was clearly brought about by the buckling of the track as the rear coaches of the preceding train passed over it. The rails had been unable to expand on a very hot day and were therefore subjected to undue compression. Consequently, it had only required the thrust and vibration of a fast train to release the locked-up stress which overcame the lateral resistance of the ballast, which was short in quantity. It was the "freezing" of the fishplates to the rails which had prevented expansion; this freezing had occurred, in spite of the fishplates having been oiled, because the fishbolts had not been slackened. In his remarks upon the accident the inspecting officer points out that, like others of a similar nature that have happened in the last few years, this accident was mainly the result of failure of the permanent way staff to carry out completely the instructions on the special precautions to be taken during hot weather, and to this a shortage of ballast contributed. He recommends, however, that the various instructions on the subject should be amplified to make clear the action to be taken to ensure free expansion of rails, and that sections of the line on which ballast is known to be weak for any reason should receive attention in priority to others when a spell of very hot weather appears imminent.

The East African Groundnut Scheme

A WHITE PAPER, published on Wednesday morning, indicated that the Government has abandoned its original plan for groundnut production in East Africa. It is to be replaced by a new and severely limited scheme. When the plan was first drawn up the intention was to clear 3,210,000 acres by 1953, and revision last November reduced that area to 600,000 acres, which, it was hoped, would be cleared by 1954. Now it is proposed to restrict operations to a total of 210,000 acres over the next seven years. The White Paper says that the revised programme submitted by the Overseas Food Corporation "involves a radical change in the whole conception of the scheme." The aim originally was to increase production of oils and fats to meet a world shortage, which was, and still is, expected to persist. But, the White Paper adds, the scheme must now be regarded as a scheme of large-scale experimental development to establish the economics of clearing and mechanised or partly mechanised agriculture under tropical conditions.

Steel and the Motor Vehicle Industry

THE Society of Motor Manufacturers and Traders announced on Wednesday last that sheet steel supplies to the British motor vehicle industry were being seriously reduced. A statement issued by the Society said that, with record outputs coming from the British steel industry, the motor vehicle industry had hoped to maintain its present production. A decline in imports of sheet steel from abroad, however, and the effects of the rearmament programme had resulted in the motor industry's supplies this quarter being reduced. That would mean that some companies might only be able to work a four-day week, a state of affairs which would last until more steel was available. The output of the motor industry, the statement continued, which was estimated at 140,000 cars and 65,000 commercial vehicles last quarter, might therefore be cut by 15 to 20 per cent this quarter, the cut falling mainly on cars. It was understood, the Society added, that there could be no increased sheet steel from British sources until the new mills at Margam came into production.

Water Power and Water Storage in 1950

No. I

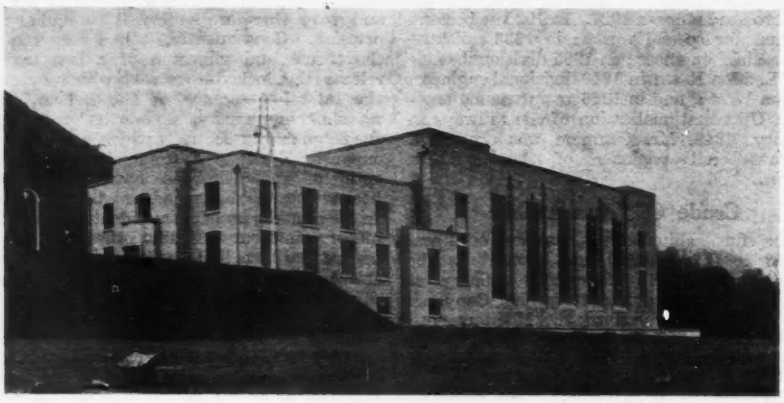
THE almost universally increased consumption of electric power in the post-war world, combined with the greater cost of coal, has given a great stimulus to hydro-electric construction. In spite of capital restrictions in many countries, there was a great deal of hydro-electric construction in progress in 1950, testifying to widespread needs for greater generating capacity. The year was therefore one of great activity.

During the fourth World Power Conference, which was held in London last summer, about twenty-five papers on hydro-electric developments and practice were presented (see THE ENGINEER, August 4, 1950, page 132, for a general summary of these papers), which gave an interesting overall picture of the stage of development to-day and some indications of future trends in design. Considerable improvements in the design of Francis turbines have meant that both Francis and Kaplan machines are now being used over greater ranges of heads. Francis turbines have been designed and installed to operate under heads as high as 1000ft, and Kaplan turbines are being supplied in the United States for heads as high as 100ft. The gravity dam is, in general, being superseded by more economical structures, such as buttress dams or earth or rock-fill dams, modern soil mechanics and compacting methods having greatly increased the possibilities of these types. There have also been great improvements in the design of pressure pipe-lines.

The size of hydro-electric installations seems to have approached the economic limit. Economic limitations have proved to be more severe in many cases than physical limitations, so that future practice, at least in European countries, is likely to show a scale of sizes closely resembling those prevailing to-day. There are, of course, exceptions to these generalisations, particularly in the case of multi-purpose schemes for irrigation and flood protection, as well as power supply. Another point which may be noted is the tendency to reduce the number of turbo-alternator sets installed in a power station, increased reliability and flexibility of operation allowing one or two sets to be used where perhaps four would have been favoured in earlier designs.

Scottish Projects

The year 1950 was a notable one for the North of Scotland Hydro-Electric Board, in that its first three major projects came into operation during the year, thus making a substantial contribution to generating capacity. Now that the Board's first-stage programme of works on these projects at Loch Sloy, Tummel-Garry and Fannich is virtually completed, a start will be made in 1951 on further constructional schemes.



CLUNIE POWER STATION

The official opening of the Loch Sloy project took place in October, and the four machines installed in the power station at Inveruglas, with a total capacity of 130MW, are now available for easing peak load demands in the Glasgow area. Work still remains to be done, however, in completing the system of aqueducts in the surrounding catchments. The project was described in our issues of July 21st & 28th, Aug. 4th & Oct. 27th last.

The works at Tummel-Garry and Fannich, which had been nearing completion by the end of 1949 were accelerated as much as possible in 1950, and in the case of the Clunie station near Pitlochry were finished by February 12, 1950, when the first machine was turned round.

The operations for closing the three temporary openings through Clunie dam were carried out on February 3, 1950. The raising of Loch Tummel was then put in hand and by February 12th it was raised to 456·5 O.D. Further raising of the Loch to its full level of 472 O.D. was not possible until October 7, 1950, when the construction of the drum gates was completed. In Clunie power station, which is illustrated herewith, the first machine came into commercial operation on April 3, 1950, the second in August, 1950, and the third on November 12, 1950.

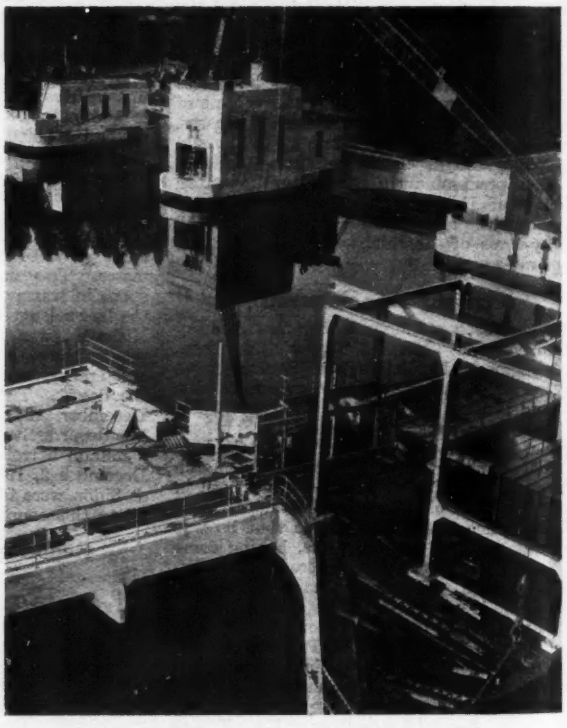
When Loch Tummel reached its new top-water level, the appearance of the new loch was considered to be very satisfactory, especially at the top end.

On the Pitlochry section of the work, good progress was achieved. The four large flood openings through the dam were closed on July 26, 1950, by temporary steel gates dropped into position at the upstream side of the dam. Thereafter the concreting of the four openings was carried out. This operation involved the placing of about 50,000 cubic feet of concrete under difficult conditions. The reservoir was filled to its top-water level of 300 O.D. on August 21, 1950, and the first machine came on to commercial load on October 30, 1950. The raising of the water level in the reservoir to 300 O.D. has formed a very attractive loch at Pitlochry.

After the dam openings were closed, the question was, would fish negotiate the fish ladder? The fish ladder had been punched with three plate glass windows in an underground observation room so that fish could be seen moving upstream through the ladder. For a period of five weeks during which watchers were continuously employed, 809 fish were observed moving upstream.

The upper illustration on Plate 10 shows the dam and power station at Pitlochry with the drum gates spilling. The fish ladder can be seen in the foreground. There are two Kaplan turbo-alternator sets in the power station, each rated at 7·5MW and normally operating at 167 r.p.m. under a head of about 45ft. The dam is 475ft long and 54ft in height, each drum gate being 90ft long and 16ft deep.

The catchment area of the rivers Tummel and Garry, supplying the Pitlochry dam and power station, covers about 322 square miles. Some of the higher streams of the aqueduct will eventually be diverted into the Errochty reservoir, this development forming the second stage of the project, which was started in 1949. A tunnel 6 miles long will lead from Errochty reservoir to the power station at the upstream end of



CLUNIE TUNNEL ENTRANCE AND CLUNIE DAM

Loch Tummel, which will generate under a head of about 550ft. The Clunie power station is connected to Loch Tummel through a tunnel some 9000ft in length, the construction of which was described in THE ENGINEER of March 10 and 17, 1950. The accompanying illustration shows the entrance to the Clunie tunnel in the foreground, with the drum gates and control superstructure of Clunie dam behind. The Clunie power station contains three 20MW Francis turbo-alternator sets operating under a net head of 160ft. Loch Faskally, as the reservoir formed by Pitlochry dam has been named, is immediately downstream of Clunie power station.

BENEVEAN DAM

The estimated power production of the Tummel-Garry project is the highest of any of the Board's schemes, totalling about 300 million units annually, of which about a third will be produced at the Errochty power station. Of the first stage production of about 200 million units, about a quarter will be generated at the Pitlochry power station and the remainder at the Clunie station.

As may be noted from the accompanying illustrations, precast concrete facing blocks have been used for facing the Pitlochry and Clunie power stations, the architectural design of which has resulted in a pleasing and impressive appearance. The consulting civil engineers for the Tummel-Garry project are Sir Alexander Gibb and Partners, the electrical consultants being Messrs. Merz and McLellan. The main contractors are George Wimpey and Co., Ltd., the Cementation Company, A. M. Carmichael, Ltd., and P. and W. MacLellan, Ltd. The drum gates and other hydraulic equipment were supplied by Glenfield and Kennedy, Ltd.

The Fannich project, which consists of a tunnel from Loch Fannich nearly 4 miles long, followed by a pipe line leading to the power station, was also designed by Sir Alexander Gibb and Partners and Messrs. Merz and McLellan, the main contractors being Balfour Beatty and Co., Ltd. This project constitutes the first stage of the development of the Conon basin, where a group of schemes with an annual production of 437 million kWh will eventually be constructed. The annual output of the Fannich scheme alone will be about 83 million kWh.

An important date for this project was September 7, 1950, when the 15ft thick rock plug between the tunnel and the bed of the loch was successfully blown (see THE ENGINEER, September 22, 1950). The scheme was then rapidly completed, and the first of the two 12MW machines at Grudie Bridge power station was brought into commercial operation on November 9, 1950, and the second on December 18th, providing much needed power to the North of Scotland.

THE MULLARDOCH–FASNAKYLE–AFFRIC PROJECT

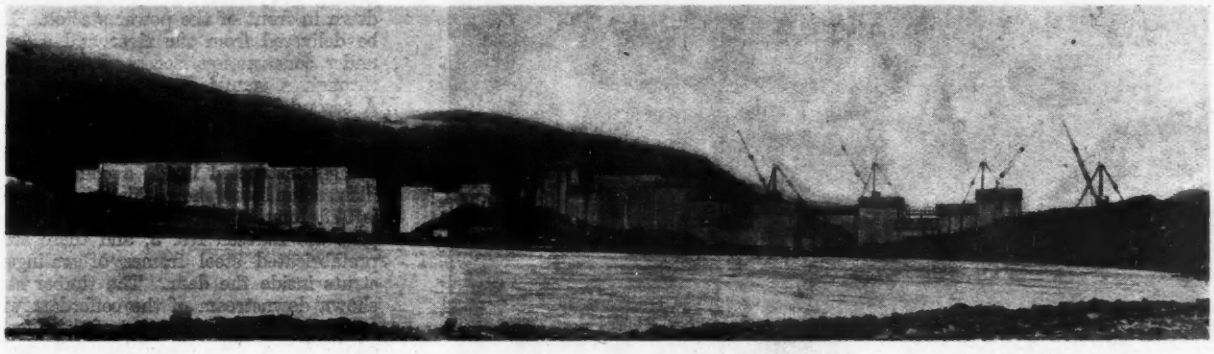
Good progress was made in 1950 on the Mullardoch-Fasnakyle–Affric project. The second tunnel of the scheme, an unlined tunnel connecting Loch Mullardoch and Loch Benevean, was holed through early in December, and construction of the control gate housings for this tunnel is proceeding. As may be seen from the progress photographs reproduced herewith, which were taken towards the end of last year, the Benevean dam is approaching completion and the Mullardoch dam is well advanced.

The Mullardoch tunnel will connect the reservoirs formed by these two dams. There follows a second tunnel, including a shaft and a high-pressure section, leading to the power station. At present the construction of the intake works just upstream of the Benevean dam is in progress, the tunnel itself having been completed. The power station is also well advanced and installation of the main turbo-alternator sets is in progress. The estimated annual power production is 223 million kWh, from three 22MW Francis turbine sets operating under a gross head of 522ft.

The Mullardoch dam is amongst the largest of the dams in this country. It is built in two wings, with an obtuse angle between them, thus sealing off the two sides of the valley, which are separated at the dam site by a central island of high ground. The panoramic illustration of the Mullardoch dam which we reproduce shows this configuration. It also shows the Bailey bridging on which the narrow-gauge track used for transporting the concrete skips is laid, and the derricks and other plant in use. The length of the dam is 2385ft, with a height of about 100ft. Both dams are mass-concrete gravity structures. The consulting engineers for the Affric project are Sir William Halcrow and Partners, and Messrs. Kennedy and Donkin for the electrical and mechanical work; the main contractors are John Cochrane and Sons, Ltd.

Work was proceeding in 1950 on a project with an annual output of some 80 million units at Glen Shira. There are two dams in this scheme, the larger being 130ft high and 2250ft long. The power station will have one 40MW vertical Francis turbo-alternator operating under a gross head of 160ft, the largest machine so far ordered by the Board. The consulting engineers are Messrs. Babtie, Shaw and Morton.

Several smaller projects were also in



MULLARDOCH DAM

progress for the North of Scotland Hydro-Electric Board during the year. Of these, we illustrate the 40ft high arch dam of the Lussa project, on the Kintyre peninsula. The Board's smaller schemes are in general intended to benefit the immediate neighbourhood in which they are situated, by supplying power for local requirements. The Lussa project will supply electricity to Campbeltown and the coastal villages and dwellings on both sides of the peninsula, and the distribution lines will link it with the Glen Shira development. The scheme will have an annual output of about 8·5 million kWh, from two 1MW horizontal Francis turbo-alternator sets, operating under a gross head of 380ft. The catchment area is about 13 square miles, and the consulting engineers are Messrs. James Williamson and Partners, and Messrs. Strain and Robertson.

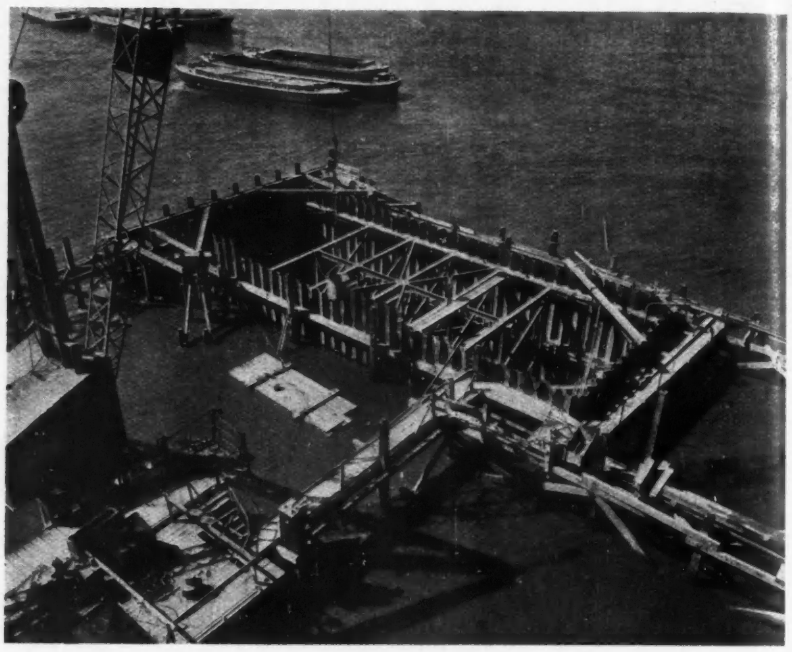
Other projects under construction for the Board in 1950 were at Gairloch, where 3 million units will be produced annually in the first stage, and at Cowal, where the annual power production will be about 14 million units from two 3MW horizontal Francis turbine sets operating under a gross head of 400ft. The first stage of the Storr Lochs project was also in progress on the Island of Skye. This scheme will yield about 3·5 million kWh annually, and will operate in parallel with the Lochalsh scheme, one of the two small completed schemes of the Board which were opened in 1948.

Wales

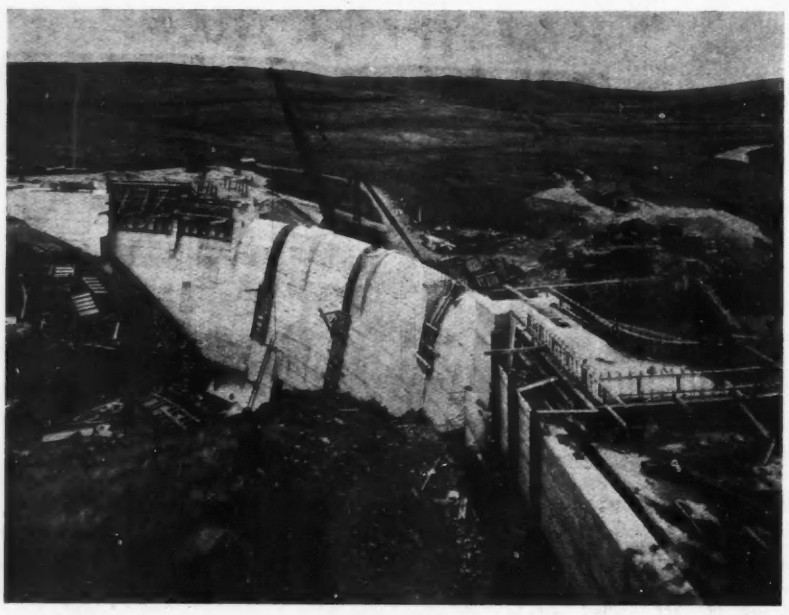
Interest was aroused last April by the publication of the British Electricity Authority's memorandum on the proposed hydro-electric developments in North Wales. These developments were first outlined in 1948, but were still being investigated last year. The appearance of the memorandum gave rise to some controversy, several expressions of which appeared in our correspondence columns at the time.

The most noteworthy example of constructional projects in Wales is, however, provided by the Claerwen dam, which is under construction in the Elan Valley to augment the storage capacity of the reservoirs of the Birmingham Water Department. The dam is a gravity structure of mass concrete faced with masonry, and a recent photograph of the progress of the work, showing Blocks 1 to 12 (there are twenty-three blocks altogether) is reproduced in Plate 10.

The dam will provide a maximum storage of 10,800 million gallons, as against the existing total storage of 11,175 million gallons of the other reservoirs in the valley. Its completed dimensions are a height of 185ft from stream bed to crest, and an overall length of 1120ft. Some 161,000 cubic yards of excavation and 379,000 cubic yards of concrete are involved in its construction. The consulting engineers for the Claerwen dam are Sir William Halcrow and Partners, and the contractors Edmund Nuttall, Sons and Co. (London), Ltd.



COFFERDAM AT BANKSIDE



LUSSA DAM

Thermal Power Stations

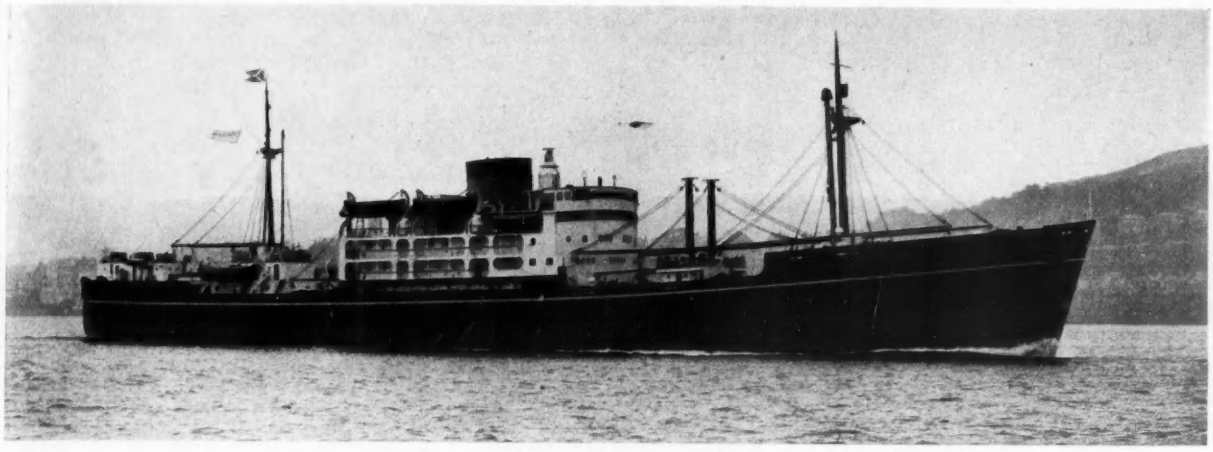
It should not be forgotten that, in spite of the great interest of hydro-electric projects, as far as this country is concerned, a far greater volume of civil engineering work was in progress in 1950 for the construction of thermal power stations. This subject is reviewed in our article "Electrical Engineering in 1950," but one example is given below of the civil engineering aspects of the work.

On the south bank of the River Thames in London, the construction of the first stage of the Bankside power station made good progress during the year. This station will have an installed capacity of 240MW, with four 60MW sets and eight 375,000 lb per hour oil-fired boilers. Oil will be stored in underground tanks below the access road and down in front of the power station. It will be delivered from the river and a jetty is under construction, access to which will be through a tunnel from the power station. A second tunnel, the cooling water intake, will also be incorporated in the jetty, the part of the jetty containing those works being constructed inside a cofferdam. The illustration below shows this cofferdam, which is 97ft long by 40ft wide. The steel sheet piles are Larssen No. 3, and there are five prefabricated steel frames of walings and struts inside the dam. The timber staging shown downstream of the cofferdam will be utilised for the construction of the remainder of the jetty. The consulting civil engineers to the British Electricity Authority for the Bankside power station are Messrs. Mott, Hay and Anderson, and the contractors are Sir Robert McAlpine and Sons, the constructional department of the B.E.A. being responsible for the plant.

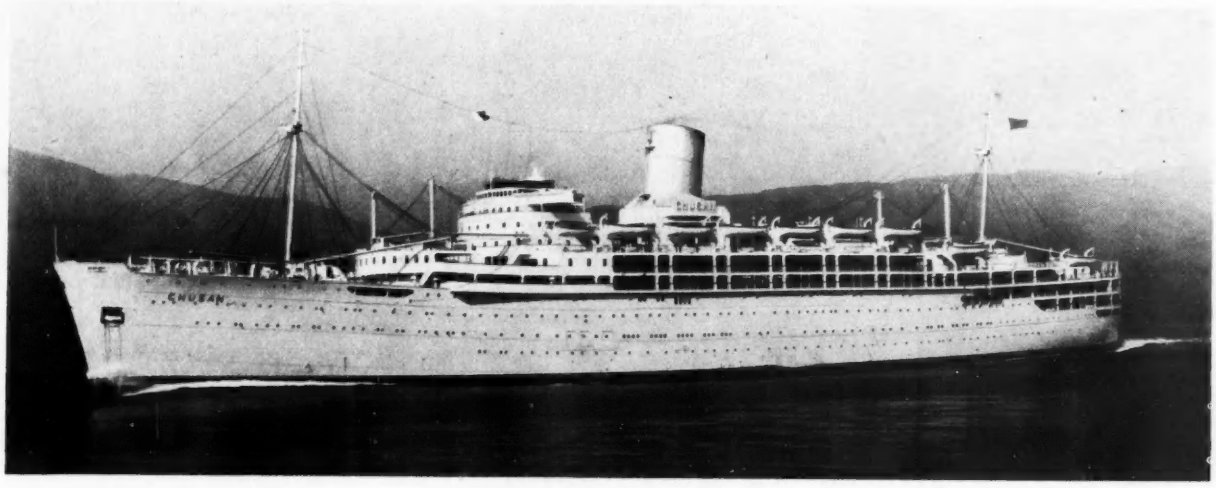
(To be continued)

The British Standards Institution, 24–28, Victoria Street, London, S.W.1, announces the appointment of Mr. H. A. R. Binney, C.B., as director and secretary in succession to the late Mr. Percy Good.

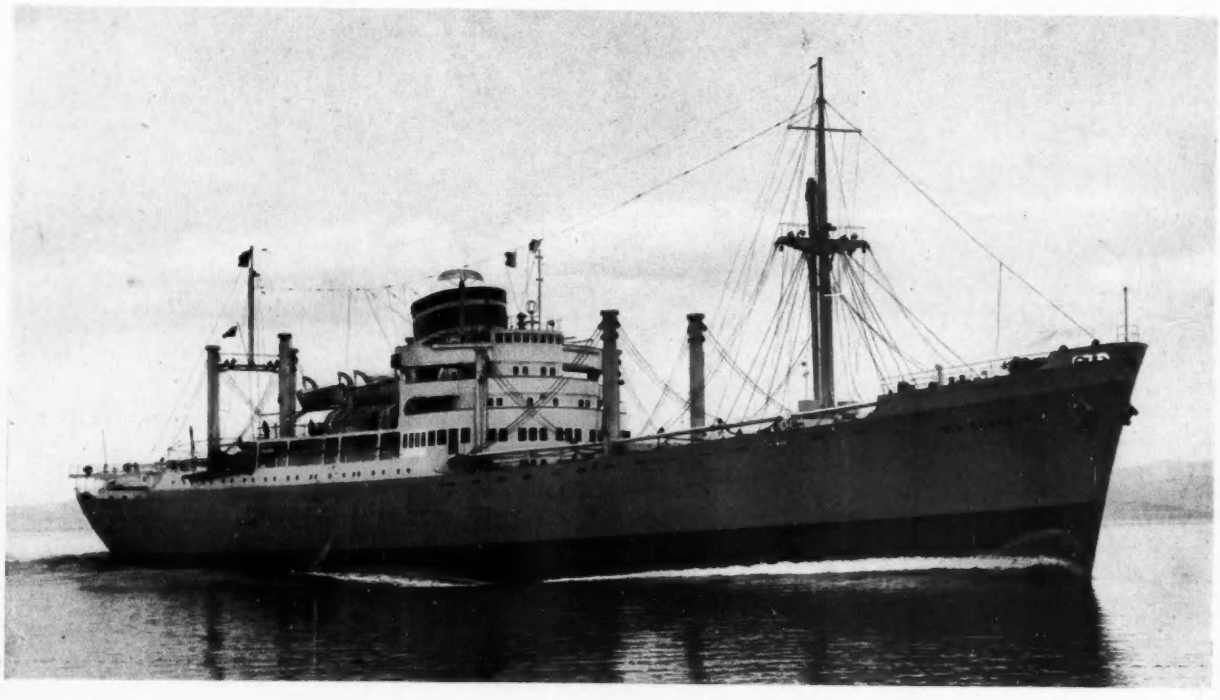
PASSENGER AND CARGO LINERS OF 1950



INDO-CHINA STEAM NAVIGATION COMPANY'S "EASTERN QUEEN"

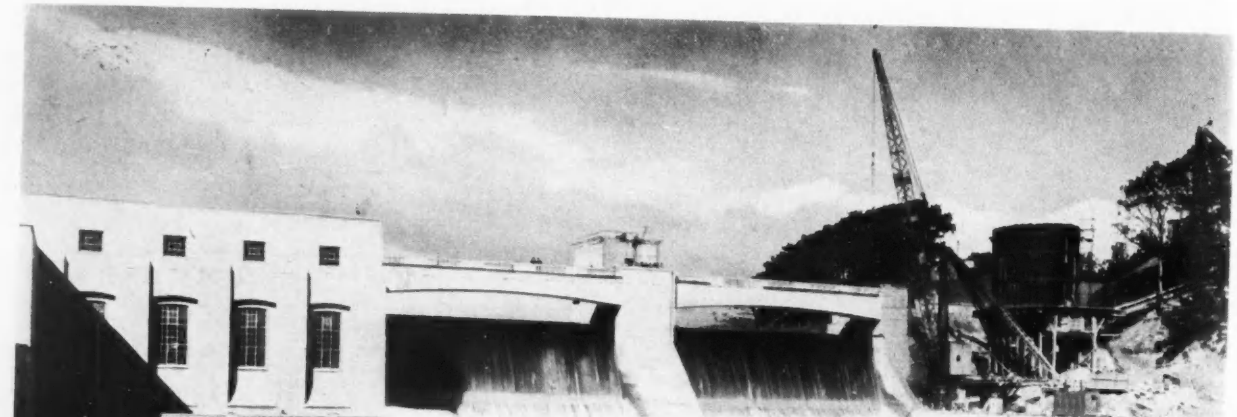


P. AND O. LINER "CHUSAN"

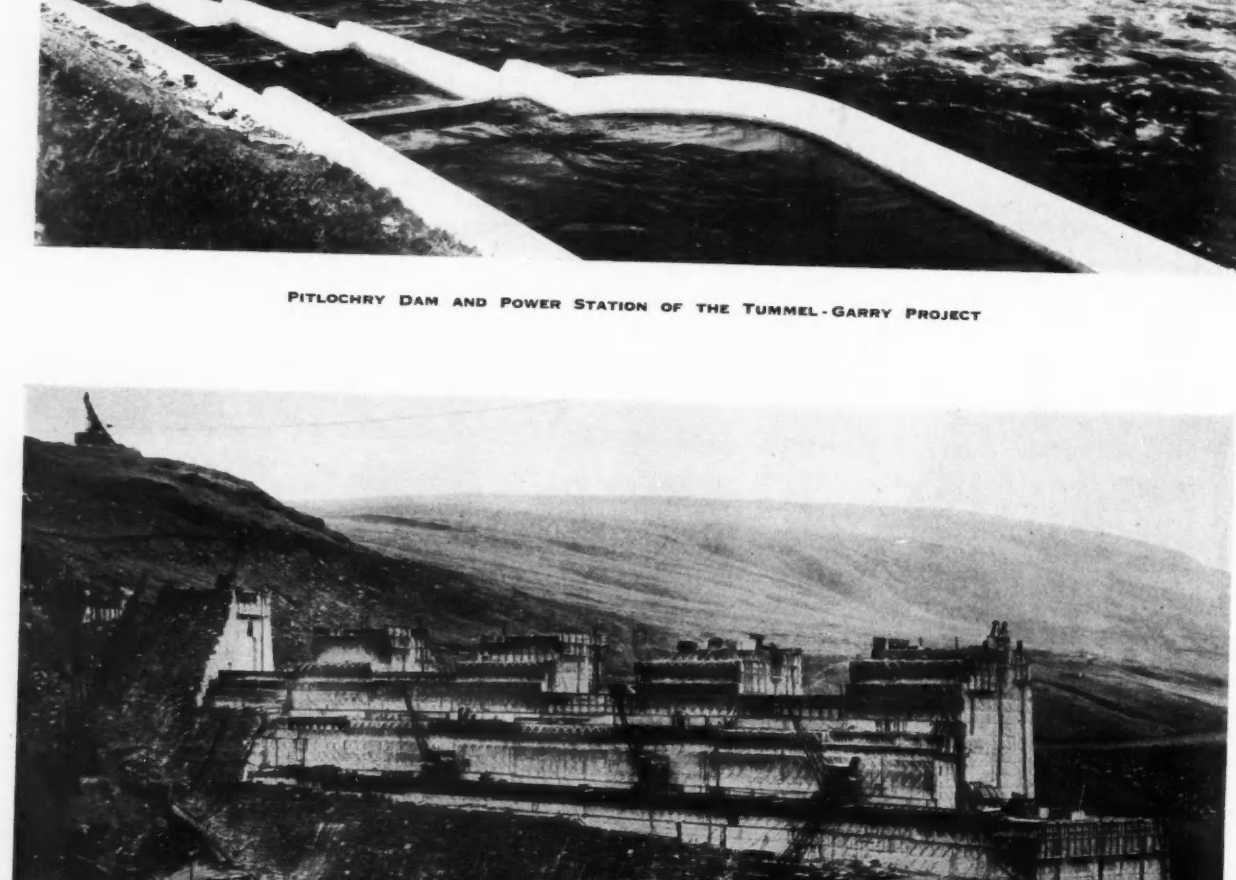


FLOTA MERCANTE DEL ESTADO'S M.V. "RIO BERMEJO"

CIVIL ENGINEERING PROJECTS IN 1950



PITLOCHRY DAM AND POWER STATION OF THE TUMMEL-GARRY PROJECT



CLAERWEN DAM

The Royal Navy To-day

(By Our Naval Correspondent)

No. II—*(Continued from page 4, January 5th)*

The True Submarine

SO far we have considered only the extent of the menace which we know confronts us at the present time. The immediate future presents a much more serious problem—a submarine with an entirely new type of engine for submerged propulsion, requiring no air, which was designed by a German and had reached the experimental stage when the war ended. The British, Americans and Russians have all had access to the four U-boats then building with an engine of this type, and after exhaustive investigation and experiment the United States Navy is building at least one submarine with these engines at the present time. Whether the Russians have yet got to the building stage seems doubtful, since they are not renowned for their technical skill in engineering and shipbuilding. But we underestimated their military skill when the Germans attacked them in 1941, and as they have had German scientists and submarine engineers working for them since the war it would be wiser to assume that in their progress in submarine design they are not far behind the Americans and ourselves.

The general characteristics of this new engine have already been described in this journal, but both in this country and in the United States the utmost secrecy is maintained regarding improvements since 1945, the speed anticipated and, in fact, any details of the engine which has now been produced after five years of experimental work. It is a Walther closed-cycle engine using hydrogen peroxide of 90 per cent purity as oxidant for the fuel, and the Germans claimed that two engines of this type should give a submarine an underwater speed of 25 to 26 knots. The vessel is able to proceed for prolonged periods wholly submerged, independent of any "schnorkel," at high speed, at any depth desired and thus becomes a genuine submarine instead of merely a ship that is able to submerge. In this connection it should be noted that the asdic installation can be used in a submarine to give warning of surface vessels in the vicinity and to fire her torpedoes without having to come to periscope depth to sight the target. The estimated cost of running the engine is, however, reported to be about £5000 an hour, and the high cost of, and probable difficulties in obtaining the fuel in large quantities may restrict the use of the engine to periods when it is most required. There is, however, no reason why a diesel (with "schnorkel") should not also be installed for charging the batteries required for lighting and auxiliary motors and for use when cruising and when "all is quiet overhead."

But the future of the true submarine does not depend only on the Walther cycle engine, for the Americans appear to have overcome the difficulties of applying nuclear power to submarine propulsion. Congress has recently been asked for money to construct a submarine with a nuclear plant which is believed to follow the general lines of the plant now being built by the Westinghouse Electric Corporation at Idaho. Using enriched uranium as fuel, it is said to be designed to operate at about 60,000kW and at a temperature of 2000 deg. Fah. The heavy weight of the pile and shielding will no doubt be compensated for to some extent by the elimination of the heavy batteries now used for submerged propulsion, but a new design of hull will be necessary in view of the radical modifications required to accommodate a nuclear power plant in a submarine. The speed may well be 25 knots or more, depending on the size of the turbine installed, and as no question of refuelling arises the submarine will have unlimited range. Air for the crew can be carried in condensed form—both in this and the Walther cycle type of submarine—and the carbon dioxide removed by conventional methods. Neither radar nor aircraft will be effective against these types and their high speed will give them the legs of all but the very fastest surface vessels. The problem of locating and destroying submarines proceeding at 25 knots at depths of 100ft, 200ft or 300ft is, indeed, not going to be easy to solve.

A New Type of Anti-Submarine Vessel

From the foregoing paragraphs it is clear that the speed of an effective anti-submarine vessel will need to be in the nature of 30 knots to deal successfully with modern types of submarines now in service and about 35 knots to cope with the submarine of the immediate future. Such speeds rule out the possibility of further reliance on engines of the merchant ship type, which enabled corvettes and frigates to be built cheaply, quickly and in large numbers during the war. Speeds of this nature and the complicated and expensive electronic and anti-submarine installations required nowadays also mean that the ships will be costly—they will probably cost about £1 million apiece. After five years of experiment the Admiralty have at last produced a design for a suitable vessel—fast, lightly gunned, with a strong anti-submarine armament and large endurance—and it is thus most disappointing that under the rearmament proposals only two anti-submarine vessels are to be laid down. This can hardly be called even the beginning of a replacement programme. It may well be that the Admiralty is not yet satisfied with the new design and hesitates to begin a large programme, but lack of finance is more likely to be the reason for the delay. The British people are inclined to forget that the submarine nearly defeated this country in both the two World Wars, while vividly remembering the bombing and the disadvantages of having an enemy on the other side of the Channel and North Sea. A force of 2,800,000 men, organised in 175 divisions, 25,000 tanks and 19,000 aircraft ready to drive across Europe seem a more immediate, more understandable threat than 300 submarines, and it is not surprising that the attention of Parliament is at the moment concentrated on building up fighting formations for our deplorably weak Army.

Minesweeping Vessels

Russia has always proved expert in the manufacture of the latest types of mines, and it may be anticipated that her submarines and aircraft will be employed laying mines—particularly magnetic, acoustic and other types difficult to sweep—on a large scale. To meet this threat, the rearmament measures provide for the laying down of forty-one minesweeping vessels of new design and we have still sixty-six wartime minesweepers available to deal with the normal type of mine. A beginning has also been made with the building up of stocks of degaussing equipment for merchant ships.

Construction and Maintenance

When the war ended, no potentially hostile large surface fleet remained in being, and both Britain and the United States scrapped large numbers of ships then building. In this country it was decided to continue the construction of nine aircraft carriers (in addition to three earmarked for the Dominions), three cruisers, eight destroyers and some lesser vessels, but subsequently work on three of the carriers and on the three cruisers was indefinitely postponed. All the remaining carriers and five of the destroyers have since been launched and their completion dates are now to be hastened. Great attention has been paid to habitability and the destroyers are being fitted with electric galleys and modern laundry and bathroom facilities. They are of all-welded construction and are to be in service by the end of 1952.

The Royal Dockyards have been fully occupied since 1948 in refitting ships of the reserve fleet, and the need for civilian work which they took in hand immediately after the war to maintain full employment has now entirely ceased. Latterly more and more work has had to be placed out to contract, and as a result of the rearmament speed-up in refits, eighty-nine vessels of the reserve fleet, including seven destroyers, nine frigates and sixteen fleet minesweepers are being refitted at private repair yards. Some 450 reserve fleet ships will have been refitted at least once during the past three years, and it has been possible to maintain a policy of replacing, without delay, a seagoing unit due for refit by a ship from the reserve in an efficient state. Special attention has been given to ships in category A which are intended to be equipped, stored, ammunitioned and manned with a full war complement within fourteen days of an emergency arising.

The reserve fleet is now organised in six divisions, which are located respectively at Portsmouth, the Clyde area, Harwich, Plymouth, Sheerness and Chatham, and each division is known by its own name ship with the object of simplifying internal organisation and preserving the entities of the divisions. The fact that the ratings wear the cap ribbons of their name ship is an incentive to competition. Where practicable, the same standard of habitability is aimed at during the refits as is now being adopted for new ships under construction. The alterations and additions in the cruisers "Swiftsure," "Ceylon," and "Gambia" which have recently been refitted are typical of what is being done. These ships have been provided with electric galleys and bakeries, refrigerated stowage for fresh fruit and vegetables, drinking water coolers and soda fountain bars in the canteens, stainless steel wash basins in bathrooms, each with its hot and cold water supply, shaving light and mirror, shower baths, up-to-date laundries capable of handling the washing of the whole ship's company, a cinema and an internal broadcasting system over which programmes can be relayed direct to the mess spaces.

In the field of naval aviation plans are in hand to replace the piston-engined fighter aircraft at present in use by the new gas turbine Vickers-Supermarine "Attacker" and the Hawker "Sea Hawk," a jet interceptor from which the "Hawker" P.1040 and P.1081 have been developed. The existing two-seater all-weather fighter "Sea Hornet" is to be replaced by the de Havilland "Venom" night fighter, one of the fastest British fighters yet in production, and the

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Westland "Wyvern" with an airscrew-turbine engine, is to be the Navy's strike fighter. New anti-submarine aircraft, capable of attacking as well as locating submarines, are to be selected from the Fairey "17," the Blackburn "Y.A.5" and the Blackburn "Y.B.1." Further progress was made during the past year in investigating methods of improving the performance of carrier-operated aircraft, which need to be more robustly built than their land-based opposite numbers to withstand the extra strains of landing-on and assisted take-off. The experimental rubber deck on which a jet "Vampire" landed successfully eighteen months ago marked a definite advance in this direction in permitting the undercarriage to be replaced by skids. A rubber deck also permits of much faster landing speeds in a limited space. Last year jet "Vampires" landed successfully on a carrier for the first time at night.

The explosion and subsequent fire in July in a lighter when loading ammunition at the Bedenham ammunition depot near Gosport, which was afterwards found to have been caused by sabotage, created considerable disquiet throughout the country. There have been eleven cases of suspected malicious damage in R.N. ships and establishments during the past six months, but Government spokesmen have assured Parliament that there is no evidence of a planned campaign of sabotage. In an interview on the subject the First Lord of the Admiralty attributed these cases to three main causes: carelessness, negligence and individual action resulting from personal grievances engendered possibly by a background of subversive propaganda. Under the last heading, the First Lord added, the incidents had been of a minor character and clumsy of execution, as, for example, inserting sand in the drain side of the lubricating system of a ship's main engines.

In view of the need for administrative economies in the Navy, the Government decided in April to close down the dockyard at Bermuda, one of Britain's oldest naval bases. Docking facilities at this base have hitherto been provided by two floating docks, one for ships of up to 14,000 tons and the other for frigates and comparable vessels. The dockyard has been more expensive to run in relation to its usefulness than any other, wages are high and the establishment is too old and too small to be run economically. The composition and strength of the America and West Indies Squadron will not be affected, but in future the squadron will be maintained by ships from the Home Fleet and refits and repairs will normally be carried out in the United Kingdom. It will, however, continue to use Bermuda as its headquarters and the Commander-in-Chief's residence, together with the necessary recreational facilities for the ships' companies, will be retained, thus preserving the traditional association of the Royal Navy with Bermuda.

A measure of great importance to the Fighting Services was taken by the old Parliament shortly before its dissolution, when it passed a Bill authorising the Treasury to advance during the next five years a sum of £40 million for the construction of married quarters in this country for the Armed Forces, thus placing Service houses on the same footing as those constructed by local authorities for the civilian personnel. The Navy is to have 3200 of the 30,000 houses to be provided under the Bill, but it is the present intention to build these houses at isolated naval establishments and not at the home ports. The transfer of the Royal Naval Engineering College from Keyham to Manadon, near Plymouth, which will take another seven to ten years to complete, has been advanced a further stage by the building of two new blocks at Manadon. One is to house the laboratories and class rooms and the other a factory in which training in moulding, founding, boilermaking, welding, &c., can be carried out. Both Keyham and Manadon are meanwhile being used as the Engineer Officers' Training College, under the name of H.M.S. "Thunderer," with some 400 officers under training, the majority being drawn from public and secondary schools.

The Admiralty has recently published detailed accounts of successful salvage operations carried out by the Admiralty Salvage Organisation, formed during the war to increase and co-ordinate the salvage potential of this country. This organisation has now become an integral part of the Boom Defence Department and is to be retained permanently as an essential defence measure, both for the study in peacetime of the technique of saving and raising ships and as a necessary requirement in modern amphibious operations. It is not intended to compete in any way with British commercial concerns, but the large number of items of salvage equipment maintained by the organisation at bases both at home and abroad are available for hire by commercial firms.

Standardisation

To ensure the greatest possible economy of effort and in the use of combined resources among the three navies primarily responsible for the safety of the vital North Atlantic area, a committee of flag officers from the United States, British and Canadian navies has for some time been studying the problem of arriving at common doctrines and methods in the conduct of naval operations. In its report issued in April, and since approved by the naval chiefs of staff of the three nations, the committee recommends further discussions. They should determine common objectives in the overall fields of naval warfare wherein standardisation would be practicable and beneficial. Subsequently staff officers on a lower or "working" level should make a detailed study of each of the particular problems involved where standardisation has been recommended in a broad field. This will make possible the gradual development of common designs and standards in arms, equipment and training methods and thus very greatly reduce the operational and technical obstacles to co-operation among the three navies. The committee's recommendations are, in fact, merely a step towards the fulfilment of the wider arrangements in general military standardisation called for under the North Atlantic Treaty defence organisation.

Research and Development

The new types of submarines and anti-submarine vessels already referred to are evidence that the intensive research carried on since the war both here and in the United States is at last producing concrete results. No details of the new vessels are available nor is there any information about the new types of offensive and defensive weapons now under investigation in this country, apart from a statement by the Parliamentary Secretary to the Admiralty that improved types of the "homing" torpedo are in the experimental stage. This torpedo, which "picks up" the target and sets its own course, was used by the Germans in the war and successfully countered.

The United States Navy Department is not so secretive and from time to time promulgates results of its research and experimental work, which are very encouraging. U.S. naval aircraft have recently been fitted with a very sensitive search radar, which permits the detection of smaller targets such as a "schnorkel" "over a much greater distance than heretofore possible." Unofficial reports indicate that our new types of anti-submarine aircraft have a similar type of radar installation. Another announcement from the U.S. Navy Department also suggests that the sonobuoy—which was used as a submarine detection device in the last war without marked success—has been improved. It has been installed in the new model of the U.S. Navy's long-distance reconnaissance aircraft "P.2 V," specially designed for anti-submarine operations. These small radio buoys are dropped in a specific pattern over the area where the presence of a submarine is suspected. Floating on the surface, the buoys lower small hydrophones to a set depth, which detect the submerged submarine's propellers and the vibrations are automatically transmitted to the aircraft overhead. Receivers in the aircraft enable the operators to plot the submarine's position by interpreting the relative noise level transmitted by the sonobuoys.

Information from the United States Navy Department indicates a recent development in the manufacture of atom bombs, which seems likely to be of great importance in naval warfare. The "AJ-1" carrier-operated attack bomber, with a take-off weight of only 27½ tons, is now able to carry an atom bomb, which can only mean that there has been a marked reduction in the size and weight of the assembled missile. The two atomic charges of the bomb, each just under the critical size, are kept apart by launching or detonating gear, which has hitherto been so heavy and cumbersome that it required a Superfort of the "B29" type to carry it. If, however, the total weight of the bomb can be reduced to something like a ton, there is no scientific reason why it should not be used as the warhead of a German "V2" type of guided missile for launching either from surface vessels or submarines. The latter could carry a weapon of this type without difficulty and fire and guide it while submerged. And in view of the advance in anti-aircraft defence measures, it may well prove more effective to launch atomic missiles from submarines than from aircraft. Submarines should in any event find this a much easier operation than to attack adequately escorted merchant ships.

The Americans, indeed, make no secret of their view that the rocket—large and small—is to be the weapon of the future, both for offence and defence. Recent developments in the sphere of large guided rockets are a 12,000 lb bomb which can be guided all the way to the target, and self-propelled guided missiles with ranges of over 500 miles. The new air-to-air rocket, which has successfully passed its tests for use in naval fighter and interceptor aircraft, is evidence of the progress in the development of the smaller types of rocket. It is small enough to be carried in quantity in modern high-speed aircraft, has much greater range and speed than the aircraft rockets used hitherto and brings bombers under fire at a range beyond the latter's defensive power. Equally good progress is being made with surface-to-air rockets, and General Lawton Collins, Chief of Staff of the United States Army, recently expressed his confidence that "the anti-aircraft rockets now in advanced stages of development will be able to destroy aeroplanes at altitudes above 60,000ft."

While, however, guided missiles and inter-

ceptor aeroplanes will play an increasingly important part in protecting the fleet from aircraft attack, the anti-aircraft gun is still regarded as an essential weapon, and United States Navy reports show great advances in the rate of fire. The 3in twin mountings now being installed in United States ships are fired at the rate of fifty rounds per gun per minute, and a 3in gun under development is expected to have twice that rate of fire. The accuracy of anti-aircraft fire is being greatly assisted by the new jet-powered "K.DM.-1" pilotless target drone, which has a wing span of only 10ft and is released by a "mother" aircraft when the necessary launching speed and height have been reached. The ram-jet engine then starts up and thereafter the tiny aeroplane is controlled by radio, its movements being watched on a screen.

Following the tests of material and equipment of ships of the Royal Navy in the Arctic seas in 1948, further tests were carried out in northern waters in 1949 to assess the ability of men to survive under very cold conditions. The nine men involved, all volunteers, embarked in the minesweeper "Truelove" in January and subsequently endured successfully a stay of five days, clad in survivors' suits, on an improved pattern of naval life float, in a gale of wind with air temperatures of minus 10 deg. to minus 15 deg. Cent. They were given a minimum diet of 1500 calories daily, consisting of two tubes of condensed milk, a small bag of toffee and two-thirds of a pint of water. Later the same men proceeded to Singapore and carried out survival tests on a float moored in tropical waters. Specific tests were made of the effects of certain items of diet, such as salt, which minimise the effects of heat exhaustion.

Personnel

By the end of this financial year the strength of our naval personnel will have been reduced to 127,500, as compared with 140,000 on April, 1, 1950. The reduction is being achieved partly by administrative economies in shore establishments and partly by reducing the intake of National Service men—whom the Navy does not require—from 10,000 to a token number of 2000 annually. About 20 per cent of the 2000 will be reserved for artificer ratings, whose call-up is deferred until completion of their apprenticeship and for men volunteering for air duties. The remaining 80 per cent is intended for those who have served for one year in a naval or marine volunteer reserve force prior to doing their National Service. Sea cadets must therefore join one of those reserve forces if they wish to do their compulsory time in the Navy. National Service men will be encouraged to volunteer for training as officer pilots and observers in the Royal Naval Volunteer Reserve air squadrons, subject to an engagement of five years in the R.N.V.R. at the end of their compulsory service. It is intended that these volunteers should eventually replace the wartime officers now serving in the R.N.V.R. air squadrons.

Since the war long-service recruits have been joining the Navy in adequate numbers, either as boys who join for twelve years' continuous service engagement or as young men between the ages of seventeen and twenty-three who join either for twelve years or for a special service engagement of seven years with the fleet and five years in the Royal Fleet Reserve, a force now fixed at a strength of 25,000 men, which will in war provide the ratings for a large part of the complements of our Reserve Fleet ships. There is, however, a serious shortage of skilled men—particularly craftsmen—owing to the reluctance of senior men to serve another ten years for their pension after completing their first period of twelve years. The situation has been made still worse by the large number of boys who, before reaching the age of eighteen, are exercising their option recently granted to them of turning over to the Special Service engagement. Full employment and high wages ashore have been a great inducement for a skilled man of thirty to leave the Service, but fortunately the Government has seen the red light in time. With the very large pay increases approved in August last for the Armed Forces, ratings are now financially as well off as they would be in civilian occupations. A chief petty officer, for example, has had his pay increased from £4 4s. 6d. to between £6 13s. 6d. and £7 7s. a week, exclusive of a weekly marriage allowance of £2 10s. and the other substantial benefits he has, such as daily rations, duty-free tobacco, &c. It is confidently anticipated that men will now both revert to continuous service and also re-engage for pension in the numbers required, though men still regard the scales of pensions as inadequate. An increase of pensions for the Armed Forces is, however, under consideration. The recommendations of the Chorley Committee have now been adopted and the pay of the Royal Corps of Naval Constructors—a civilian branch of the Navy—is to be adjusted accordingly on the level of Civil Service salaries.

Approximately 30 per cent of naval personnel are now concerned directly or indirectly with naval aviation, and this is the chief reason for the large number of officers and men still serving in naval establishments ashore—rather more than half the total personnel at the beginning of 1950. The personnel of the Women's Royal Naval Service are also proving very efficient as air mechanics, and they are now being selected for the responsible duty of pilot's mate. The one week's biannual training for certain branches of the Royal Fleet Reserve has recently been resumed, and it is hoped soon to extend it to the whole of this force, whose training has been in abeyance since the war. A number of these reservists, together with certain officers on the emergency list—about 1000 in all—have had to be called up to enable ships of the Far Eastern Squadron to be brought up to war complement. Recruiting for the Royal Naval Reserve (Merchant Navy officers and men) has also been resumed, and it is hoped that the strength of this force will reach the 6000 mark by the end of March. The strength of the Royal Naval Volunteer Reserve (civilians who do fourteen days' annual training and weekly harbour drills) is at present fixed at 9000 officers and men, a number quite inadequate for war requirements, but difficult to increase while all but 2000 conscripts join the Army or the Royal Air Force.

According to the First Lord, the high quality of cadets for Dartmouth has been maintained under the new age sixteen entry scheme. Half the cadets come from public schools and the remainder from State schools and naval training establishments. The lower deck now provides 25 per cent of all officers in the executive and supply branches and Marines and up to 15 per cent in the engineering and electrical branches. Ceremonial uniforms for officers—full dress, frock coat, &c.—have been abolished. The only uniforms to be worn in future are the monkey jacket for day wear and mess undress or a modified mess dress, with white waitcoat, but not gold-laced trousers, for evening wear.

WESTERN UNION FLEETS ASSEMBLE OFF PENZANCE

Exercises and Operations

Apart from naval operations in Korean waters, 1950 has been an outstandingly busy and successful year in the sphere of collaboration between the navies of the various Western Union and Atlantic Treaty Powers, and there has been a marked advance in the development of a common tactical doctrine and practical understanding between them. British naval forces have exercised frequently with United States squadrons in the Mediterranean, Caribbean and Pacific; with French naval units in the Mediterranean; and with French and Dutch forces in the Channel and Western Approaches. Most of the exercises have been designed to practise communications and co-operation in convoy defence, anti-submarine and aircraft operations, but there have been main armament firings and amphibious training. Opportunities have also been taken to exercise British naval forces with units of the Canadian, New Zealand, Indian and Pakistan navies. R.N.V.R. sea training has been intensified and several visits by R.N.V.R. motor launches and minesweepers were made during the summer to French, Dutch, Belgian and Scandinavian ports. R.N.V.R. air squadrons embarked in carriers for deck-landing practices, one flew 150 miles from its base to attack the Home Fleet on passage

and another flew to Malta to operate from the carrier "Theseus" and carry out anti-submarine exercises with the Mediterranean Fleet.

A British naval force of one carrier and the "Unicorn"—a carrier maintenance ship—three cruisers and several destroyers, frigates and lesser vessels has co-operated with the United Nations' forces in Korea by carrying out bombardments on troop concentrations, factories, bridges, shipping, oil tanks, supply and ammunition dumps, barracks and gun emplacements, and in covering amphibious landings. The light fleet carriers "Triumph" and (later) "Theseus" have assisted in maintaining continuous air support for the troops and have carried out air strikes to meet all operational requirements. These operations by British naval forces serve only to "highlight" their exacting and continuous routine work of maintaining local control of sea communications, often in extremely bad weather and under hazardous conditions. The fine work done by a Royal Marine commando unit, which was flown to Korea, was recently commended in the House of Commons.

Coal in 1950

By Sir RICHARD A. S. REDMAYNE, K.C.B.

No. I

SINCE there are some aspects of the coal industries of countries other than Great Britain which have, or may have, an important bearing on our own industrial economies, especially in relation to export, it is worth while to start this survey by a reference to them.

The Price of Coal

Though, during the past year, the price of coal generally showed some tendency to fall, owing to the somewhat cheaper cost of production, that change was more in evidence, perhaps, in the case of Germany and Poland, than in the case of other European countries; but prices still remained very high in European countries. Probably, the most cheaply produced coal in the world is that of South Africa, but Australia is one of the few coal-producing countries in which production costs are not excessively high, the cost in 1947 averaging about 17s. per ton, though it has since increased. In South Africa, since 1939, the average price of coal has increased only 37 per cent, i.e., from 5s. 4d. per ton to 7s. 4d. per ton, whereas, according to Mr. D. G. Malherbe, the Government Mining Engineer,* "In the case of Britain and the European countries, this increase is nearly 150 per cent. In Britain for instance, the price has increased from 18s. 4d. in 1939 to 45s. in 1949." As showing what this change means in regard to the production of power, he points to the fact that the Escom undertaking, where over 80 per cent of their electrical power is generated, the average price per unit sold and delivered is 0·26 of a penny, whereas in Great Britain the corresponding charge is about 0·75 of one penny, the cost for coal only being 0·39 of a penny per unit, which is 50 per cent more than the total production and distribution costs at Escom.*

Germany

The estimated production of "black" coal in Germany in the year 1949 was 108 million metric tons, but an additional output of brown coal (sometimes, though erroneously, termed lignite) is estimated to have reached 100 million metric tons. It will be seen, therefore, that of all the countries participating in the Schuman plan discussions, Germany will, in regard to coal, occupy the strongest position.

It was announced in the Press of January 3, 1950, that the question of broadening the scope of the "Ruhr Authority" inside Germany to abolish the coal and steel control groups would be considered at the meeting of the British authorities concerned at Frankfurt. It will be remembered that the work of the coal group has been concerned with supervising production, allocation for exports and reorganisation. Production is now in German hands, and allocation of exports is now recommended by the Ruhr authority, with the advice of the central group, whilst reorganisation has been planned by the Germans, though the Allies have made preparatory surveys. The German plans contemplated the creation of fifteen to eighteen new companies, the assets of which were to pass to public trustees by June, 1950, pending a decision by the Federal Government on socialisation.

German coal exports for 1949 exceeded 22,500,000 tons, compared with 18,000,000 tons for 1948; and the allocation submitted to the European distribution organisation at Geneva is now based more on type and quality. The quantity exported by Great Britain (inclusive of bunker coal) in 1949 was just over 19 million tons.

The Schuman Plan

One effect of the nationalisation of the coal-mining industries of so many European countries was to offer the inducement to politicians of devising schemes of international control of prices, and it is probably due to this inducement that we owe the creation of the Schuman plan, the announcement of which certainly constituted one of the outstanding events of the year as affecting the coal and iron and steel industries of Europe. Early in May of the past year, Monsieur Schuman, the French Foreign Minister, announced that his Government proposed to place the whole of the French and German coal, iron and steel production under a common "high authority"; that it would be open to all other European countries to join in; and that details of the plan had been sent on May 9th to Britain, Belgium, Holland, Luxembourg, Germany and Italy. The French Government stated that they were prepared to open negotiations on the basis that:

(1) The common high authority should ensure fortwith the modernisation of production and improvements of quality.

(2) Coal and steel should be supplied to the German and French markets and to the markets of the participating nations under identical conditions.

(3) Exports to other countries should be from a common pool of production.

(4) Conditions of labour in the industries throughout the participating nations should be "equalised."

This ambitious plan called for the equalisation of prices, shipments were to be free of Customs duty between the adhering countries, and a unified transport tariff would be necessary.

The high authority would consist of delegates chosen by the respective Governments on an equal basis, with a president selected by the same Governments; disputes to be settled by an arbitrator.

Monsieur Schuman maintained that the proposal did not prejudice the right of ownership in the various enterprises and denied that the organisation took the nature of a cartel.

Such a revolutionary scheme was sure to arouse doubts and suspicions in the minds of economists, of business men, and of those concerned in the industries affected, and our own Government was, perhaps unjustly, criticised for not at once welcoming the proposals, for there are many points in them which should be considered and carefully weighed before committing the country to so far-reaching a project. Taking the matter of exports alone, as Sir William Smithers pointed out in a letter to *The Times* of August 25, 1950, we are very largely dependent on our exports of coal, iron and steel for our economic existence, which, as he put it, "are our life blood." If anything is done to stop them, then "England becomes a liability, and not an asset in European recovery," for we are not a self-supporting country. Furthermore, we have in these, our chief exports, to compete with the Ruhr and Poland. With the ending of the Marshall Aid and the sellers' market we shall have to export goods and services at world competitive prices or starve.

On August 10, 1950, Monsieur Schuman informed the Consultative Assembly of the Council of Europe that agreement had been established by the representatives of France, Germany, Italy, Holland, Belgium and Luxembourg, and it was proposed to draw up a treaty to put the agreement into action. A six-Power conference was arranged to be held in Paris and, by mid-August, considerable progress had been made in the working out of details.

The high authority is to have from six to nine members, and their essentially non-representative character is emphasised by the fact that the accession of a new member nation to the plan will not necessarily involve an increase in the membership of the "High Authority." The Committee of Ministers will approve, or disapprove, the High Authority's work, and the Common Assembly, or Council, will co-operate and consult with the High Authority to ensure that the decisions are fully informed, in other words, it will be the instrument which will communicate the policy requirements of the countries to the High Authority. The fundamental aim is the creation of a single market within which all barriers and quantitative restrictions will be eliminated. The High Authority will have at its disposal an equalising fund for the purpose of compensating the disparity between existing cost price differences. The principle of this fund, to be fed by contributions from the low-priced industries and to provide subsidies for the high-priced industries, was adopted.

The High Authority will control investment and research.

There is fear in some French quarters that if Britain, which, of all the countries concerned, has the largest individual output of coal and steel, stands out of the pool, then Germany might use the scheme to dominate all French heavy industry.

The final report of the Conference, not available at the time of writing, will be awaited with interest.

French Coal Production

In view of what has been stated above about the Schuman plan, it may be of

* *Journal* of the Chemical, Metallurgical and Mining Society of South Africa, April, 1950.

interest to readers to be informed as to the extent of the production of coal in France. The following figures express the situation in millions of metric tons:—

	1938	1949	1950 (est'd)
Production	47·5 ...	53·0 ...	54·0
Supplied from Saar } imports }	22·0 ...	4·0 ...	6·0
		17·0 ...	10·0
Exports	1·1 ...	4·0 ...	1·5
Total less exports ...	68·4	73·0	68·8

United States of America: The Great Coal Strike

The world output of coal in the year 1949, in metric tons, was 1,632,000,000. The U.S.A. was the biggest contributor to this immense figure, for she produced 437,868,036 tons of soft coal alone. Anything seriously affecting the coal industry in that country must have repercussions elsewhere.

The strike of 370,000 workers at the soft coal mines is to be reckoned as such a calamity. "Soft coal," it may be explained, is a term used in America in the differentiation of bituminous coal from anthracite. This strike, which commenced on September 19, 1949, continued into 1950 and, early in February, President Truman invoked the Taft-Hartley Labour Law to meet this stoppage. Mr. Lewis, the miners' leader, sought to force the owners to increase the basic wage of about £5 a day and to pay a larger sum into the so-called welfare fund for each ton of coal mined. The stoppage so reduced the stocks of coal that, early in February, an average of only about twenty days' supply was available; but the miners defied the court's order and their union's order to return to work.

It was not until March 4, 1950, that the strike terminated. The men, under Mr. Lewis, had claimed 95 cents an hour increase; they accepted 70 cents and an increase of 10 cents per ton in the owners' contribution to the welfare fund, instead of 15 cents—the eight-hour shift to continue instead of the seven-hour sought by the miners. On Sunday, March 5th, the agreement embodying these terms was accepted by the miners employed at mines producing 70 per cent of the soft coal. The output of soft coal in 1949 was 27 per cent below that of 1948.

The British Coal-Mining Industry

Early in the past year the results of the coal-mining industry for the year 1949 were available, and on June 29, 1950, the annual report of the National Coal Board was issued, which showed an improvement in respect of the profit earned, quantity of coal produced and in coal exported; but though the financial side of the industry was so much bettered, the improvement, it will be seen, was in some measure, at any rate, due to the profit earned on exported coal, and it is very questionable whether, in the face of intensified foreign competition, such prices as were then obtainable can be maintained or whether the rate of export can be sustained.

The operating profit amounted to £31,136,700, as against £17,514,956 for 1948, or, after all deductions, there was a surplus carried to the balance sheet of £9,466,813, as against £4,658,965 for 1948. Production from the collieries of 202,700,000 tons was 5 million tons more than in 1948. With the output from opencast workings of 12,400,000 it gave a total saleable output of over 215 million tons, so reaching the Government's target of 215 to 220 million tons. The home consumption in 1949 amounted to about 196 million tons, or about 2 million tons more than in 1948, and the volume of exported coal, inclusive of cargoes and bunkers, to over 19 million tons, which was several million tons better than the estimate. The cost of production was, however, generally speaking, above the inland price of the coal.

As *The Times*, in reviewing the 1949 situation, remarked in a leading article in its issue of July 1st last, "the Board recognise that its financial position is not yet stable, since it depends largely upon the relatively high prices secured in export markets. Most of the colliery profits come from three divisions, Yorkshire and the East and West Midlands."

Until late in the year it was difficult to prognosticate what would be the result for the year 1950, in the absence of completed statistics, but it seemed doubtful whether, in view of shortage of manpower, continuance of high rate of absenteeism, enhanced wages costs, increase in the cost of transport and intensified foreign competition, together with a rising home consumption, the results would be as good as those for 1949. This fear was unfortunately realised in fact before the end of the year.

Financial Results

Statistics relating to financial results, production costs proceeds and wages are, at the time of writing, available only in respect of the first three quarters of the past year; those financial results are as follows:—

	Operating profit		Profit or loss after provision of interest, compensation, taxation, &c.
	Collieries	Ancill's & other commitments	
	£	£	£
First quarter ...	9,953,001	660,000	5,600,011 profit
Second quarter...	6,728,971	470,000	2,451,971 profit
Third quarter ...	3,459,476	500,000	460,524 loss

It is, of course, difficult at this stage to foretell what will be the final result for the year for the reasons already mentioned, but from the information already available it seems improbable that the profit for the year anywhere near equalled that of 1949.

After the issue of the first quarterly statement it was surmised by some critics that the Board could not expect to continue to make the profits shown in that statement, which indicated that the coalfields of Northumberland, Cumberland, Durham, Forest of Dean, Bristol and Somerset were worked at a loss, the heaviest loss being in respect of Bristol and Somerset of nearly 11s. 7½d. per ton.

This prediction, it will be seen, was borne out in fact. For the profit surplus was due to the high prices, 20s. to 25s. a ton above that charged at home, at which 5 million tons of coal were exported.

Production

The production of coal from the collieries during the three quarters under review was as follows:—

	Output Tons	Disposable commercially Tons
First quarter, 1950 ...	52,579,624 ...	48,450,960
Second quarter, 1950	50,083,774 ...	46,337,819
Third quarter, 1950 ...	46,943,609 ...	43,507,378

According to the economic survey, the coal output target for 1950 was 205 to 210 million tons for deep-mined coal, compared with 202·7 million tons obtained in 1949, but the provisional figure for the total output achieved in 1950 was recently given as 204,116,000 tons. Opencast coal, which in 1949 amounted to 12·4 million tons, was put at 13 million tons for 1950, or a total of 218 to 223 million tons, as compared with 215 million tons in 1949. It was abundantly clear from the first that if the home requirements were to be met and, if, at the same time, there were to be exports, inclusive of bunkers, of 20 million tons, the higher figure should have been aimed at. But by November it was clear that coal output was falling behind expectation, and early in December the Government stopped all exports and authorised the Board to import about a million tons from America.

Costs of Production

One had hoped that the slight reduction in cost of production witnessed in 1949 would be not only maintained, but be improved upon in 1950, and this hope was supported by the results shown in the first quarter's statement, but not in those of the two succeeding quarterly statements, as the following figures show:—

Cost Per Ton of Saleable Coal

	s. d.
Last quarter, 1949	44 10·1
First quarter, 1950	44 5·5
Second quarter, 1950	45 3·6
Third quarter, 1950	45 11·0

The reduction in cost of production witnessed in 1949 was due to general economies introduced by the Board. Labour cost had risen by about 4s. per ton. As wages costs constitute about 65 per cent of the total cost of production, output per man employed is a very important factor in relation to cost. Any increase in the former or decrease in the latter means an enhancement of the total cost, other items inherent in the total remaining static. Thus, owing to an increase in the wages bill during the year and in spite of a marked decrease in manpower, it will be surprising if costs do not prove to have risen above the level of 1949. Those for 1949 were 180 per cent higher than in 1938.

On January 12, 1950, Mr. Latham, director-general of finance of the N.C.B., in a written statement to the Transport Tribunal said the Board viewed with apprehension the prospect that coal-class traffic should be burdened with increased charges which might ultimately prove to be unjustified. He pointed out that the increases (then proposed, but since implemented) would cost the Board £2,200,000 in 1950, including £1 million on the cost of its annual purchase of stores, materials and equipment.

Quality of Coal

Considerable disquiet continued to exist during 1950 about the inferior quality, besides the limited quantity, of the coal supplies to home consumers. On March 23rd of the past year Mr. Raikes stated in the House of Commons that the maximum amount permitted to domestic consumers was to-day no more than it was at the end of the war and that it was 14 million tons less than the amount used before the war; that "the domestic consumer was to-day consuming only 67 per cent of the amount of coal which he consumed in 1938." The quality, he thought, was 30 per cent below "pre-war," and he truthfully remarked that deterioration in quality meant that the domestic consumer needed greater quantity. At the end of a debate on coal and petrol, in the House, the Government were defeated on March 29th, the Minister of Fuel and Power failing to satisfy opposition critics, who complained of dirty coal and inadequate petrol supplies. The Minister admitted that there was more dirt in coal to-day than before the war and that it was a genuine grievance. The two basic reasons for it were, that, owing to exhaustion of the better seams, thinner and dirtier seams had to be worked and that washing and cleaning machinery had not been installed by private owners in the same proportion as cutting machinery. Those who have a close knowledge of the industry, more particularly of that side of it which is connected with the management and working of the mines, will feel doubtful whether that

explanation can be supported by facts. The Minister said that in 1938 there were 7 million tons of dirt in 234 million tons of coal and in 1949 18,300,000 tons of dirt in 220 million tons of coal. But how have those figures been arrived at? Do they represent the amount of foreign matter *only*, picked out from among the coal during the process of screening, or do they include also the amount of dirt separated from the small coal in washing, and was the same vigilance exercised in the cleaning of the coal in the two years specified so that the final products dispatched from the collieries were in an equal state of cleanness? Unless we are informed on these points, it is impossible to make correct deductions, or arrive at right conclusions relative to the respective qualities of the coal. We are informed that the N.C.B. is investigating the matter closely, but, as *The Colliery Guardian* stated in an excellent leading article in its issue of July 6th, commenting on the Board's 1949 Report, "The existing conditions not only arouse profound discontent amongst consumers and threaten the name of British coal abroad, but they entail a great waste of human effort . . . The development of a small field investigation unit to conduct 'operational research' may be regarded as a useful move, always provided that standardisation is not carried to excess, a danger always present in large-scale planning."

Prices and Export

The "proceeds" stated below, which are indicative of the average selling prices per ton of coal at the pit mouth, are recorded in the quarterly statements issued by the Board and for the last quarter of 1949 and the first three-quarters of 1950 were as follows:—

	Proceeds per ton s.	d.
Fourth quarter, 1949	48	4·8
First quarter, 1950...	48	2·9
Second quarter, 1950	47	11·8
Third quarter, 1950	47	4·7

But they afford no guide as to inland coal prices.

On May 15, 1950, owing to the then recent increases in railway charges, twenty-eight different scales of increases in coal prices came into force in the London region, varying according to freight charges. Throughout the country retail prices of domestic coal, coke and manufactured fuel were increased by an average of 2s. 6d. per ton, thus passing on the additional freight charges made by the British Railways, each district paying according to its distance from the supplying pits, so that districts far from the coalfields, e.g., South Coast towns, may pay 5s. or more per ton increase.

The average price of coal in London over some recent years, showing the great increase since 1939, are as follows:—

	s.	d.
1939	56	6
1941	65	0
1944	69	0
1948	80	0
1949	90	0
May 5, 1950	95	0

The intention of the Government to permit increased freight charges, which occasioned the increase in the price of coal and other commodities, was announced in the House of Commons by the Minister of Transport on April 25, 1950. They meant an increase in railway and canal freight charges of 16⅔ per cent. Dock charges on coastwise vessels and cargoes were raised from 25 per cent to 50 per cent over those in force in 1939 and other dock charges from 75 per cent to 100 per cent over 1939.

The economic survey for 1950 reckoned that from 19 to 22 million tons would be exported during the year; but, in view of the production obtained during the first three quarters, it had already appeared doubtful by August whether, after meeting the demands of home consumption, there would be the anticipated surplus available to fulfil this expectation. Our real shortage of coal supply was shown by the announcement in the House of Commons by the Minister of Fuel and Power on November 20th that an order had been given to the National Coal Board to buy coal from abroad. He indicated that the home consumption in 1950 would be 6 million tons greater than in 1949 and that the Government was uneasy at the fall in stocks. About a million tons would be purchased from U.S.A., and it was understood, from perhaps Poland and South African sources. But for the demand due to rearmament policies it is doubtful whether the export market price at May, 1950, of £3 14s. per ton could have been maintained during the latter part of the past year. Home consumption, as Lord Hyndley stated on April 25th, is, of course, ever on the upward trend. But can we continue to produce coal of a quality and at a price to enable us to compete successfully with our European and other rivals in the export markets? If the Schuman pooling plan comes into effective operation, if Britain remains outside it, that competition is likely soon to be intensified whether or not rearmament affects the issue.

Consumers' Councils

The reports for the year ended June 30th of the Industrial and Domestic Coal Consumers' Councils, which were presented to Parliament on July 20th, dealt largely with the question of the quality of the coal provided by the N.C.B. These reports consider that it may be some years before the collieries will produce sufficient coal to meet demands. As to quality, they put forward a suggestion, somewhat surprising considering its source, that in some circumstances it may be more economical for consumers to adapt or install plant designed for high-ash-coal, rather than that the Coal Board should clean all coal. This sounds like a policy of despair. On the whole, the reports were very disappointing, and they do not disclose what useful function these Councils, as at present constituted, are fulfilling. Under the system of private enterprise there was no difficulty in obtaining redress in the matter of quality of the coal supplied. If the purchaser did not obtain satisfaction he went elsewhere for his coal. But this redress is not possible under a system of State monopoly.

An admirable statement of the position of Consumers' Councils, written by Mr. A. M. de Neuman, under the title "Consumers' Representation in the Public Sector of Industry," was published during the year. On page 16 thereof the author says: "The Domestic Coal Consumers' Council reported in the second year of its existence 'The complaints which we have received to date have not revealed any serious defect to which we should draw your attention. They . . . could have been cleared through the normal machinery.'" Comment is needless. On page 17, alluding to the Consumers' Councils in general, Mr. de Neuman remarks: 'The Councils did not seem to be in the mood to investigate pedestrian complaints from consumers and merchants; their apparent aspirations were to discuss problems of policy; complaints were canalised elsewhere."

(To be continued)

Critical Review of Gas Turbine Progress 1950

(Contributed)

THE past year was one of consolidation without many outstanding events to record. There were only two new orders for commercial gas turbines placed in Europe, both repeat orders with Brown-Boveri and Co. In the U.S.A., on the other hand, the General Electric Company announces that it has orders for twenty stationary gas turbines, though only two were mobile units. Judging from this solid business, which is being done at apparently very profitable prices, opinion in the U.S.A. must have recovered from its late phase of pessimism and may be about to become as enthusiastic as it was immediately after the war.

This side of the Atlantic most manufacturers and prospective purchasers are apparently prepared to wait and see how the large number of machines at present in construction or early stages of running behave in service before taking on further commitments.

Brown-Boveri and Co., with some eight machines in service, built since the war, is apparently satisfied, after a pause for reconsideration, as to the soundness of its designs and is undertaking further work—the first since 1946. The Beznau machines, after rectification of troubles alluded to last year, have run to schedule without further defect and have now turned out more than 100 million kWh. The 13,000kW set started up in February, 1948, has run some 6000 hours, while the 27,000kW set has run some 3000 hours since it came into service in January, 1949. As the purpose of the plant is to supplement deficiencies of hydraulic power, the heavy rains in November, which overfilled the rivers, rendered its running unnecessary.

Two other Brown-Boveri machines, whose successful running may be mentioned, are those of 1650kW installed in a cement works in Venezuela. Each has done about 5000 hours' running since starting up in September, 1949, and this plant has the distinction of being entirely dependent on gas turbines. A further 5000kW unit is now to be added.

A great deal of gas turbine and associated activity is taking place in France, where, counting schemes which originated before the war and also free-piston gas generators, some sixteen projects, are in hand. There is a 5000kW two-shaft machine in hand by Alsthom, apparently resembling the American General Electric design of the same size. A 15,000kW equipressure boiler, which will employ gas turbines in the air circuit, has been under construction for some time.

Opinion in Great Britain is not so unstable as in the U.S.A. and though some of the initial enthusiasm has been sobered by the many difficulties encountered in the industrial field, there is little evidence of the attitude that was widespread in the U.S.A. after the period of post-war publicity. A

sound understanding of the merits and demerits of different forms of plant, when based on objective considerations, allows excessive enthusiasm to be avoided and its obverse of unreasonable pessimism when unforeseen difficulties are encountered. It is noticeable that troubles with the open cycle seem to have brought about a more tolerant attitude towards the closed cycle, possibly because its difficulties are not so familiar. It may be recorded that mention of the closed cycle no longer engenders visible heat.

New Plant Coming into Service

Among the few new machines which came into service in the year, the largest was the 20,000kW semi-closed unit built by Sulzer Bros. and installed at Weinfelden, in Switzerland. This did some preliminary running in the Spring, during the period of water power shortage and, as was to be expected in a new design, which had not been shop-tested, a number of troubles were encountered.

The erection of the Escher Wyss 12,500kW closed-circuit machine at St. Denis, Paris, has at last been completed and preliminary running is expected to begin immediately. It will be recalled that this machine is similar to that being built by John Brown and Co., Ltd., for the North of Scotland Hydro-Electric Board, for installation at Dundee. There are differences not only in lay-out but in some of the components, so that the two sets will afford experience on parallel lines. The Dundee machine was due for completion during the year but is evidently somewhat behind schedule. The same apparently applies to the 15,000kW open-circuit machines ordered by the British Electricity Authority for Stretford and Dunston stations. A delay of the order of a year seems not unlikely for such machines, bearing in mind their experimental nature and the problems which have to be faced, some of which have been discovered only since the original designs were laid down. Delay is, in fact, the dominant note of the year.

Not counting gas turbine motor-cars and motor launches, only two gas turbines were completed in this country during 1950. They are the 1200 h.p. British Thomson-Houston set for the tanker "Auris," and the 3000 h.p. experimental set designed by Pametrada and built by the constituent firms for installation in their experimental establishment.

In the U.S.A. a further 3500kW machine, built by the General Electric Company, was put into service at Farmingdale. This is a single-shaft unit, employing a plain cycle, and is practically identical with that installed at Arthur Huey station last year and in the Alco locomotive. The Huey plant has now run some 4000 hours on gas without defect. The Farmingdale unit is, however, fired by heavy oil and is claimed to be the first gas turbine of its kind to employ Bunker "C" residual oil. It is intended for peak load service without any heat recovery. The expected efficiency is given as 17 per cent, with an inlet temperature of 1450 deg. Fah., and an air intake temperature of 80 deg. Fah. The price is variously quoted as 132 or 164 dollars per kilowatt.

The same company has announced that it has now obtained orders for twenty units of one or other of its two standard sizes, viz., the above 3500kW unit and a 5000kW design. This is a two-shaft machine with intercooling and regeneration and shows an efficiency of 28 per cent at 1450 deg. Fah. The selling price is quoted as 240 dollars per kilowatt. Both machines derive in some degree from aircraft technique in that they are light and small. They thus sacrifice performance to save material and this is reflected in the moderate efficiency of the 3500kW unit in relation to its high initial temperature, though not apparently in the price.

Indeed, the prices mentioned above seem to show that the gas turbine in the U.S.A. must have no competitor. They are extraordinarily high in relation to those of other plant whether regarded on per kilowatt of output or per ton of material. They work out at the order of £3000 per ton; whereas steam turbines sell at about £800 per ton and diesel engines at about £500. The prices per kilowatt, which are assumed to cover the gas turbine unit and auxiliaries, are about of the same order as the total cost of large steam stations in the U.S.A., which are much the same as in this country, ranging from 140 dollars to 200 dollars per kilowatt. They include the entire steam power plant, with buildings, civil works, switchgear, cabling, ancillary buildings and site development. On the other hand, the gas turbine price applies to a rather small unit, in which range a steam station would be appreciably higher in first cost and also in cost of attendance. What may seem surprising is that such costly gas turbines can compete either in price or running cost with the diesel engine, since the installations are either in oil-producing regions or at least where oil or gas is available at a price comparable with that of coal. The inference is that the diesel must also be dearer in the U.S.A. than in Europe, despite its wide application in railway traction, or, that the gas turbine has other powerful attractions, such as novelty.

Locomotives

The gas turbine locomotive ordered from Brown Boveri and Co., by the former Great Western Railway arrived in January and has been running on the Western Region lines of British Railways throughout the year though not allocated to any standard schedule. Certain troubles have been encountered, though they do not seem to have interfered greatly with its serviceability. The main points of criticism do not concern the power plant but the heating boiler or the brake compressor. These faults will be rectified in the other gas turbine locomotive with Metropolitan-Vickers equipment, which is approaching completion, and though this set has a considerably higher rating (3500 h.p., as against 2500 h.p.) the behaviour of the two locomotives in service will provide an interesting comparison.

The Alco-G.E. 4500 h.p. locomotive, which first took to the rails in November, 1948, had run some 27,800 miles up to November, 1949. It proved dearer to run on diesel fuel than a diesel locomotive, but on Bunker "C" the comparison is stated to be more even. The locomotive was returned to the makers for certain modifications and was later back in service on the Union Pacific.

Three other locomotives with gas turbines are nearing completion in the U.S.A. One is to be powered by a 4000 h.p. Westinghouse-Lima Hamilton free-piston engine gas turbine. Another is by the Baldwin Locomotive Company for the Atcheson Topeka and Santa Fe Railway and has an Elliot gas turbine. The third is an American Locomotive Company's locomotive with Allis Chalmers coal-fired gas turbine, which has been under test for some time. The coal-firing experiments in conjunction with this test are still proceeding, a run of some thirty-eight hours having been reported.

Vanadium Attack

Nineteen-fifty will go down in gas turbine history as that of vanadium attack. Previously there had been periods of serious depression over vanadium deposits, particularly in England, but though vanadium attack was suspected by some there was no authentic proof of it until the publication, late in 1949, of a thesis by Paul Amgwerd, of the Zurich Polytechnic. This paper reported researches suggested by Professor Schläpfer on the effects of oil ash containing vanadium in accelerating high temperature corrosion of alloys, particularly those showing a good resistance to scaling in normal atmospheres. It was shown that in the presence of such ash the protection afforded by the oxide layer on stainless steels failed, as the ash apparently acted as a flux at temperatures above about 1230 deg. Fah., the melting point of vanadium pentoxide. Further, the action was selective with respect to certain alloy constituents, some materials which were hitherto acceptable for gas turbine blades on grounds of creep resistance and scale resistance showing an alarmingly poor resistance to vanadium attack. Very serious wastage was shown to occur in periods of the order of 100 hours.

Confirmation as to the general validity of the findings was soon forthcoming from other laboratories and, though quantitative agreement is still not reached, the general rule is probably sound that the alloys in which good creep properties are obtained by large additions of cobalt or molybdenum are particularly sensitive; 18/8 stainless iron is fairly resistant and Nimonic 80 is only slightly attacked. Pure chromium is not attacked and hence some hopes are based on heavy chromium-plating of other materials, so as to produce an impervious protecting layer.

Practically all crude oils contain some vanadium, but the percentage varies with the origin. It may be possible to select oils of low vanadium content. An alternative remedy might consist in introducing an inhibitor with the oil and some work has been done along these lines. The trouble is, of course, absent where gas oil or other distillate fuel is used and those makers who, during the deposit scare, undertook only to burn distillate fuel will be congratulating themselves on their prescience. Attack is also apparently avoided at temperatures below the melting point of vanadium pentoxide—about 1230 deg. Fah.—so lower temperature machines, constituting the greater part of those in service, are expected to be immune from attack if not from deposits; 1200 deg. Fah., which has been widely selected as about the right temperature for open-circuit machines in this country, appears to be uncomfortably near the limit. On the other hand, a number of machines going into service in the U.S.A. will employ temperatures of up to 1450 deg. Fah. and are intended to burn heavy oil. These should, therefore, provide useful evidence in a very short time in actual service as to the immunity or otherwise of the constructional materials employed.

The trouble affects closed-circuit machines also, though in their case it is the air heater tubes which may be expected to waste away. The maximum temperatures selected for the circuit air in the region of 1250 deg. Fah. imply tube temperatures some 50

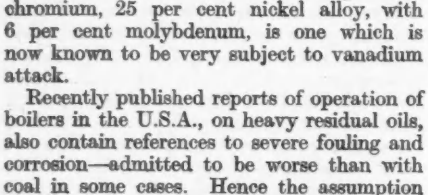
deg. Fah. higher and therefore in the active range.

A surprising aspect of the discovery is that it should be made only after some thirty years of intensive use of oil fuel in Naval and merchant vessels, and also in industry in the U.S.A. and elsewhere. In the light of what is now known, it is clear that certain troubles, such as unexpectedly rapid wasting of uncooled metal in oil-fired boilers, may be attributed to vanadium attack. The reported burning of the nozzles of the first experimental locomotive gas turbine in the U.S.A. will also be recalled. The machine was run for some 400 hours without ill-effect, but after a further ninety-two hours on heavy oil containing some vanadium some of the nozzles had practically disappeared. This was described, though not explained, as "catastrophic oxidisation." The material, a 16 per cent chromium, 25 per cent nickel alloy, with 6 per cent molybdenum, is one which is now known to be very subject to vanadium attack.

Recently published reports of operation of boilers in the U.S.A., on heavy residual oils, also contain references to severe fouling and corrosion—admitted to be worse than with coal in some cases. Hence the assumption that gas turbines could use heavy oil, because no trouble occurred with fouling in oil-fired boilers, is now proved to have been unjustified.

Water in Compression

Last year mention was made of the interest in wet compression, meaning the proposed introduction of water spray into the air so as to reduce compressor work. This has occurred accidentally in certain compressors and brought to light possible objectionable consequences. Atmospheric air always



Moisture Content of Air

contains a certain amount of water vapour and may be saturated or unsaturated. The saturation amount depends on temperature and also on pressure being strictly a function of volume. As the volume is reduced by adiabatic compression the temperature rises and there is no inclination for saturation to be exceeded. On the other hand, when the compressed air passes through a recooler, saturation is very likely to be reached and the excess water tends to condense. If provision is not made for draining the water it may be carried forward into the next stage of compression. Its effects there may be, theoretically, beneficial though practically quite the reverse.

In the presence of sulphur oxides inhaled possibly by recirculation of stack emissions and also of CO_2 the water becomes acid and may attack the metals with which it comes into contact. The resulting salts are carried forward in solution and when the water is re-evaporated in the rising temperature air in the next cylinder, the salts are deposited and may foul the blades. Secondly, the water droplets have a braking action on the blades and may damage them.

The issue of how much water is condensed and under what conditions is an interesting problem, which can best be studied by means of a psychrometric diagram, as shown herewith. Such diagrams are familiar in many techniques, such as air conditioning, but are usually drawn for a single barometric pressure. The accompanying diagram is a development taking into account changing pressure. It is drawn with water content per pound of dry air as ordinate and temperature as abscissa. Processes such as compression and cooling at constant pressure without change of water content are represented by horizontal lines defined by the initial water content. A state of partial saturation can be defined with reasonable accuracy by dividing the ordinate at the required temperature. The diagram shows that on compressing air saturated at 60 deg. Fah. to 4 atmospheres (temperature, say, 370 deg. Fah.) the air becomes much drier. However, on recooling, the saturation line for 4 atmospheres is crossed at 102 deg. Fah., and on further cooling to 80 deg. Fah. an amount of $5 \cdot 6$ by 10^{-3} lb of water per lb of air tends to condense out. In a 15,000kW gas turbine aspirating 250 lb per second of air this represents $1 \cdot 4$ lb per second or $8 \cdot 4$ gallons per minute of water to be drained off. For a more usual case of, say, 80 per cent saturated air at 60 deg. Fah., the rate of condensation will be about 5 gallons per minute or, for 40 deg. Fah. saturated air recooled back to 60 deg. Fah., the yield is about 4 gallons per minute.

That water would accumulate in such quantity was not generally foreseen and the trouble when first encountered was not immediately recognised. It occurs in open-circuit machines particularly, because of the large quantity of air drawn in, and in lesser degree in the semi-closed and closed-circuit types. In the last, only the leakage air has to be replaced so the water quantity is of much smaller order.

Shipbuilding and Marine Engineering in 1950

No. II—(*Continued from page 13, January 5th*)

Light Alloys for Shipbuilding

STEADY progress was made throughout the year in both the application of the aluminium alloys for constructional purposes and the study of the problems involved. The alloys were widely used for small craft and for non-stressed ships' structures. Aluminium alloys with physical properties suitable for incorporating into the strength girder are available but lack of suitable methods of jointing for the thicker materials retarded progress. Riveting technique was the subject of a considerable amount of investigation and rivets up to a reasonable diameter were closed. The changeover in the shipyards from riveted construction to welded fabrication meant that shipbuilders were reluctant to revert to riveting for joining alloy material. The aluminium industry was alive to the need to develop satisfactory welding methods and was experimenting to that end. Welding by the argon arc process, in which the arc is shielded by an inert gas to prevent oxidising of the weld, proved to be promising. Non-stressed structures were welded successfully by this and other methods and the Cyc-Arc Company developed a technique for welding non-heat-treatable aluminium alloy studs to plate of similar material.

Apart from jointing questions and the working of light alloy material into the main ship structure there was the problem of differential expansion and this was the subject of an investigation. The results were given in a paper, entitled "Thermal Expansion Effects in Composite Ships," read by Mr. E. C. B. Corlett, before the Institution of Naval Architects, on March 31st. The longitudinal compressive stresses induced under certain conditions were found to be large and transverse stresses were considerable. Part of the new regulations for safety of life at sea deals with fire precautions and gives a time temperature relationship. To satisfy this it will be necessary to carry out experiments similar to those which formed the subject of a paper, entitled "Stateroom Fire Test," read before the Society of Naval Architects and Marine Engineers in New York, in November, by Lieut.-Commander A. H. McComb and Mr. E. E. Benzenberg.

A considerable number of ships were fitted with wheelhouses, navigating bridges and funnels and the material continued to be used for insulation lining. Among the best examples of superstructures in light alloy was the M.V. "Blenheim," built by John I. Thornycroft, and Co., Ltd., for the Newcastle-Oslo service of the Ford Olsen Line. A smaller vessel was the "Lady Wright," constructed by John Morris and Co. (Gosport), Ltd., for service on the Gambia River, in which 35 tons of aluminium alloy were worked into the superstructures.

The use of the material in the fishing industry continued to expand as its non-toxic qualities and resistance to corrosion were more widely appreciated and the resulting economic benefits correctly appraised. Among the many examples of such applications can be mentioned the trawlers "Red Rose" and "Red Hackle," built by John Lewis and Sons, Ltd., for the Iago Steam Trawler Company, Ltd. In each vessel the fish room was completely fitted out with aluminium alloy equipment, such as divisions, shelves, hold lining and deck pound boards. The wheelhouse, charthouse, funnel and lifeboats were constructed in light alloy and many other incidental applications.

Abroad, several ships incorporated light alloys in their construction and among these we may mention the passenger and cargo ship "Gullfoss," for the Iceland fleet, the cross-channel motorship "Jens Bang," and numerous small vessels for the Norwegian coastal services, such as the "Romsdal."

Many small craft were either completely or partially constructed in light alloy during the year. The six high-speed launches completed for the Anglo-Saxon Petroleum Company, Ltd., for service in Lake Maracaibo, an account of which appeared in our

issue of May 5th, were built entirely of light metal, as was one of the prototype fire-floats built by Vosper, Ltd., and the yacht "Gulvain." There was considerable activity in the building of barges in light alloy, especially for shipment abroad, and a prototype barge, built by the Fairmile Construction Company, Ltd., was described in our issue of June 30th.

The construction of lifeboats in aluminium alloy continued to expand and the latest examples of this class of boat came from the yards of Viking Marine, Ltd., and Saunders Engineering and Shipyard, Ltd.

Liners of 1950

The ship of the year and the largest vessel completed was the P. and O. liner, "Chusan," of 24,000 gross tons, illustrated in Plate 9, which was designed for the company's service to China and Far East, which she joined after sailing on some holiday cruises. The ship was built and engined at the Barrow yard of Vickers-Armstrongs, Ltd., and has a length between perpendiculars of 630ft, a breadth moulded of 85ft, a depth moulded to "C" deck of 48ft, a draught of 29ft, and a speed of 22 knots. The vessel has well-proportioned and beautifully furnished public rooms, extensive sports facilities, including two swimming pools, and carries 475 first-class and 551 tourist-class passengers in spacious cabins. Their comfort was additionally safeguarded by the decision to equip the vessel with Denny-Brown hydrofin automatic stabilisers, to reduce the amplitude of roll. Forced rolling during trials, when an out-to-out roll of 34 deg. was suppressed in a half-swing, impressively demonstrated the capabilities of the gear and these were borne out in service.

Propulsion is by two sets of double-reduction geared turbines of "Pametrada" design, developing a normal power of 34,000 s.h.p., and an overload of 42,500 s.h.p., taking steam at 525 lb per square inch from two large and two small Foster-Wheeler boilers, with a controlled superheat range from 850 deg. Fah. to 600 deg. Fah. A distilling plant is installed to meet boiler needs and the electrical load is taken by four 850kW B.T.H. turbo-generators. A full account of the ship and her machinery was given in our articles of June 16th, 23rd and 30th.

Another liner of 1950, illustrated in our last issue, was the "Bloemfontein Castle," built and engined by Harland and Wolff, Ltd., at Belfast, for the round Africa service of the Union Castle Line. The ship is of pleasing appearance, with a distinctive low, streamlined funnel, and has a length overall of 595ft, a breadth moulded of 76ft, a depth moulded of 37ft, a gross tonnage of 18,400, and a speed of 18 knots. Excellent public room amenities are available for the 739 passengers, who are comfortably accommodated on five decks and who are in one class, an innovation which marked a departure from the company's usual practice. The main propulsion machinery consists of two Harland-Burmeister and Wain double-acting diesel engines, with thrust block integral with the bed-plate, and each having eight cylinders of 620mm diameter by 1400mm stroke and developing a total of 12,500 b.h.p. in service. The electric current required for the services is generated by four Harland and Wolff generator sets, each of 450kW, driven by two-cycle single-acting opposed-piston six-cylinder diesel engines. A more detailed description of the ship may be found in our issue of April 14th.

Last year Vickers-Armstrongs completed, at the Barrow yard, the second and third of the three liners ordered by the Instituto Argentino de Promocion del Intercambio, for service between Buenos Aires and Britain.

On both the "Eva Peron," a photograph of which appeared in our issue of last week, and the "17 de Octubre," there is comfortable accommodation for ninety-six first-class passengers and practically the whole of the cargo spaces are insulated. The ships are identical as regards general particulars and dimensions, which are: length overall, 529ft 6in; breadth moulded, 71ft; depth moulded to "B" deck, 47ft 6in; draught, 27ft 6in, and a gross tonnage of 14,500. Two sets of Parsons double-reduction geared turbines, developing 13,500 s.h.p., on service, and a maximum output of 14,500 s.h.p., drive each ship at 19 knots and take steam at 470 lb per square inch from two Foster-Wheeler boilers, having superheat control from 800 deg. to 600 deg. Fah.

Some Reconditioned Ships of 1950

The volume of ships undergoing reconditioning has been steadily shrinking as each year has seen the return to service of numbers of liners after re-conversion from their wartime status upon release from Government service. The "Carnarvon Castle" was returned to the passenger and mail service of the Union Castle Line, after an extensive overhaul in the hands of her builders, Harland and Wolff, Ltd., and the "Scythia" resumed her duties with the Cunard Steam Ship Company, Ltd., on the Canadian run. After release from serving as a troop transport, the ship made several voyages, carrying displaced persons from Europe to Canada and then was completely reconditioned by John Brown and Co., Ltd. Her profile remains unchanged but internally there has been a complete transformation, the accommodation originally designed for 2206 passengers now affording comfortable quarters for 248 first and 630 tourist-class passengers, and there are increased amenities in the way of public rooms. In the machinery spaces the gearing was renewed and the boilers received detailed attention but the rest of the thirty-year-old machinery was ready for further service after the necessary replacements were made.

The "New Australia," illustrated in last week's issue, is now augmenting the emigrant service between Britain and Australia of the Shaw Savill and Albion Company, Ltd. She was originally the Furness Withy liner "Monarch of Bermuda," which was gutted by fire during conversion from troopship service to peace-time duties. John I. Thornycroft and Co., Ltd., undertook the major reconstruction job of converting the vessel into an emigrant ship, which neither internally nor externally resembles its former self. The most noticeable feature was the replacement of the familiar three funnels by one large funnel amidship, fitted with a special cravat top of Thornycroft design, and one forward of dipod form. Although one complete deck was removed, accommodation has been provided for 1600 passengers; the majority are housed in six-berth cabins, in which extra space was gained by not fitting wash-basins. Instead, ample communal facilities have been provided in a series of washplaces along the centre-line. The whole of the Promenade deck is given up to public rooms and there are two dining rooms, having a seating capacity of 718. Despite damage by water, the whole of the turbo-electric propelling machinery, with the exception of certain minor additions and replacements, was retained and made fit for further service.

The conversion of two German liners into troopships, one by John I. Thornycroft and Co., Ltd., and the other by Alexander Stephen and Sons, Ltd., was completed during the year, the "Pretoria" becoming the "Empire Orwell," and the "Potsdam" being renamed "Empire Fowey." Both ships were built by Blohm and Voss. The accommodation in both vessels is on similar lines, cabins being provided for first, second and third-class passengers and "standee" berths, three tiers in height, for sergeants and other ranks. There are excellent public rooms and dining rooms for the cabin passengers and the troops' mess hall is designed on the cafeteria system. The original turbine machinery was retained in the "Empire Orwell," but the high-pressure Benson boilers were replaced by two of Foster-Wheeler design. In the "Empire Fowey" the whole of the turbo-electric machinery was removed and replaced by a twin set of double-reduction geared turbines, taking steam from two Foster-Wheeler boilers. A more detailed account of the work was published in The Engineer on January 27th and April 21st.

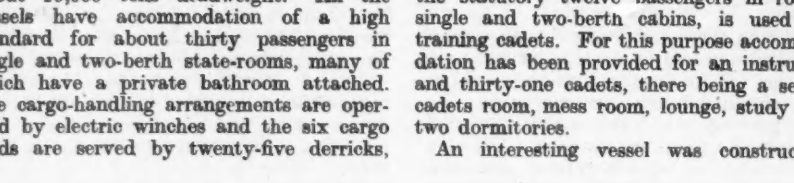
Another German liner to enter service under another flag was the former North German Lloyd liner, "Europa," which was extensively reconditioned and renamed "Liberté," to sail in the colours of the Compagnie Generale Transatlantique. The reconstruction was extensive and the French engineers remembered the criticisms of the strength of the "Europa," and took the opportunity to stiffen the hull at critical points, to improve the subdivision by increasing the height of some bulkheads, to fit fire-resisting bulkheads and to increase stability and reduce the working stresses by placing 2500 tons of ballast on board. As redesigned, the liner carries 569 first, 562 second and 382 tourist-class passengers in a high degree of comfort and a feature is the named "cabins de luxe." The quadruple screw arrangement of Parsons single-reduction geared turbines develop 120,000 s.h.p., to give the ship a speed of over 25 knots. A fuller description of the vessel was given in our issue of August 18th.

Late in the year the "Colombie" re-entered the West Indies service of the French Line, after reconversion from her duties as troopship and hospital ship. To refit the vessel for service in the tropics entailed the complete rebuilding of the interior, and comfortable accommodation, including air-conditioning of cabins and public rooms, is provided for 584 passengers in three classes. The installation of modern high-pressure boilers liberated enough space for refrigerating machinery to be fitted and so it was possible to insulate certain holds for the carriage of refrigerated cargo. An interesting system for freight handling was adopted. This is known as "Siporter," and was developed in America by the Lake Shore Company. It loads and discharges cargo through large doors in the ship's side by means of extending transporter runways and some hatchways, derricks, winches were dispensed with, thus giving more deck space.

Passenger and Cargo Liners

Alfred Holt and Co. took delivery of several passenger and cargo liners from a number of builders. The "Hector" from Harland and Wolff, Ltd., and "Jason," from Swan, Hunter and Wigham Richardson, Ltd., have a length between perpendiculars of 485ft by 69ft beam, a depth moulded of 38ft 6in and a deadweight of 11,320 tons,

while the "Patroclus" and "Perseus," built by Vickers Armstrongs, Ltd., are shorter, have slightly less beam and carry about 10,000 tons deadweight. All the vessels have accommodation of a high standard for about thirty passengers in single and two-berth state-rooms, many of which have a private bathroom attached. The cargo-handling arrangements are operated by electric winches and the six cargo holds are served by twenty-five derricks, one of which is capable of dealing with 50-ton loads. Each ship is propelled by a single set of triple-expansion double-reduction geared turbines, designed to develop 14,000 s.h.p. on service, to maintain a sea-speed of 18 knots. Machinery arrangements are such that any turbine may be cut out, while the remaining two are functioning and the lower portion of the gearcase is incorporated in the ship's structure. Two Foster-Wheeler boilers, constructed for a working pressure of 525 lb per square inch and a superheat of 850 deg. Fah., supply steam for the main turbines and auxiliary machinery.



BRITISH INDIA STEAM NAVIGATION COMPANY'S "MOMBASA"

Among the many ships taken over by the British India Steam Navigation Company, Ltd., was the "Daressa," which was the last of four ships built for the company's service between India, Pakistan and Persian Gulf ports. A motor-ship of 5515 tons gross, the vessel was built by Barclay Curle and Co., Ltd., and has a length of 375ft, a breadth of 54ft 9in, a depth of 26ft 6in, and carries a deadweight of 4260 tons. A five-cylinder Doxford oil engine, of 4200 b.h.p., constructed by the shipbuilders, gives the ship a service speed of 14½ knots. There is extensive passenger accommodation for twenty-six first-class passengers in single and double cabins, some with private bathrooms, and for sixty second-class passengers in three-berth rooms. For both classes comfortable public rooms of ample size have been provided and they are fully air conditioned to alleviate the great heat experienced in the Persian Gulf. In addition to the saloon passengers, provision has been made so that 700 unberthed passengers can be carried.

The "Chindwara," a single-screw motor-ship, was built by Swan, Hunter and Wigham Richardson, Ltd., for the B.I. Company's Far Eastern trade. The length between perpendiculars is 455ft, the breadth moulded 62ft 6in, the depth moulded 40ft 9in, and the deadweight 9574 tons. A Swan Hunter-Doxford oil engine, having six cylinders and developing 6800 b.h.p., maintains a service speed of 15 knots, while two cylindrical multi-tubular boilers supply steam for the auxiliary machinery. Derricks with capacities from 6 tons to 10 tons serve the five holds and there is a 20-ton derrick and a 30-ton derrick for heavier lifts. A point of interest is that the ship, besides carrying the statutory twelve passengers in roomy single and two-berth cabins, is used for training cadets. For this purpose accommodation has been provided for an instructor and thirty-one cadets, there being a senior cadets room, mess room, lounge, study and two dormitories.

An interesting vessel was constructed, mainly in prefabricated welded assemblies, by Henry Robb, Ltd., to meet the special requirements of the owner's East African coasting services. This ship is the twin-screw motor-ship "Mombasa," which we illustrate on this page, and which has a length between perpendiculars of 250ft by 43ft breadth moulded, a depth moulded of 19ft and carries 1364 tons deadweight on a draught of 14ft 6in. The propelling machinery consists of two British Polar two-stroke, five-cylinder diesel engines, each developing 800 b.h.p. at 250 r.p.m., to give the vessel a speed of 12 knots fully laden. The cargo is carried in three holds and there is accommodation for eight first-class passengers on the bridge deck, in well-furnished single and double-berth cabins, together with a comfortable dining saloon and a small intimate lounge. Rather simpler accommodation is provided for sixteen second-class passengers on the same deck, while No. 3 'tween decks is fitted with punkah louvre ventilation so that the space can be made available for 150 unberthed passengers with 10 square feet allowed per person.

The "Eastern Queen" built by William Denny and Brothers, Ltd., for the Far East service of the Indo China Steam Navigation Company, Ltd., is shown in Plate 9. She has a length overall of 468ft 3in, a breadth moulded of 63ft and a depth moulded of 35ft. This dual purpose ship carries a deadweight of 8800 tons when used as a cargo vessel, but there is accommodation for twenty-six first-class passengers and thirty-two Asiatic first-class passengers. Provision has also been made for 650 unberthed Asiatic steerage passengers and on coastal voyages a further 180 deck passengers can be carried. For the cabin passengers there are well-furnished public rooms and each of the double-berth first-class European state-rooms is provided with its own day-room and bathroom. With such a mixture of races, special cooking arrangements are necessary and they consist of a main galley, Asiatic galley, steerage passengers' galley and two Asian galleys. The cargo, which consists of general goods and vegetable oils, is carried in five holds, which are fitted with steel sliding hatch covers and served by derricks of 3, 7 and 10 tons capacity; the foremast is fitted with a 40-ton derrick for heavy lifts. A "drihold" ventilation and air-conditioning system is installed in Nos. 1 and 2 holds and 'tween decks and the remaining holds have mechanical ventilation. An interesting detail of the 'midship deckhouse, indicative of the trading run of the vessel, is the inclusion of anti-piracy precautions and the provision of accommodation for an anti-piracy guard.

The main propelling machinery consists of a set of double-reduction geared turbines of Pametrada design, which develop 8400 s.h.p. and drive a propeller of 17ft 10in diameter by 18ft 6in pitch at 105 r.p.m., to give the ship a speed of 17 knots. The turbines consist of an impulse h.p. turbine, which has an h.p. astern turbine fitted in tandem and an impulse reaction single-flow l.p. turbine, which incorporates the l.p. astern turbine in the same casing. Steam is supplied at a pressure of 450 lb per square inch and at a temperature of 750 deg. Fah. by two oil-fired Babcock and Wilcox single-pass boilers, fitted with superheaters and air-

NORTH OF SCOTLAND COMPANY'S "ST. NINIAN"

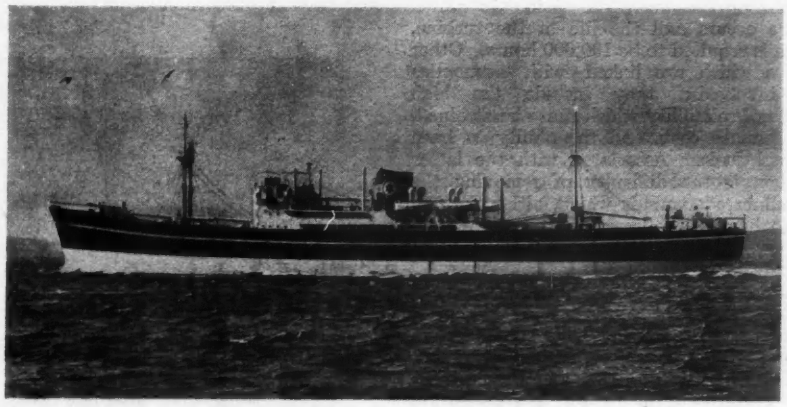
heaters in an open stokehold and using forced and induced draught.

Cross-Channel and Coastal Ships

In the first half of the year the sixth "Brighton" was delivered by William Denny and Brothers, Ltd., to the joint ownership of the British Railways and the Société Nationale des Chemins de Fer Francais, and was fully described in our issue of June 16th. This modern, sturdy craft, with its distinctive, large streamlined funnel, of aluminium alloy, and steel tripod masts, has a length overall of 311ft by 40ft 6in breadth moulded, by 16ft 9in depth moulded and carries 1450 passengers in two classes. The main engines consist of two sets of geared turbines with a combined output of 18,500 s.h.p., each set comprising a single all-impulse ahead and astern turbine, with the latter giving 85 per cent of ahead power. The double-helical main gears are contained in fabricated steel casings, with light alloy covers. Two oil-fired Foster-Wheeler boilers working on the closed stokehold forced draught principle, supply steam at 450 lb per square inch pressure and temperature of 650 deg. Fah.

The third "Amsterdam" was built by John Brown and Co., Ltd., for the night service between Harwich and the Hook of Holland to replace the "Prague," which was destroyed by fire. Designed as a two-class ship, sleeping arrangements are provided for 321 first-class passengers in cabins de luxe, single-berth and double-berth cabins, and for 236 second-class passengers in double and four-berth cabins, all of which are fitted with hot and cold running water and have mechanical ventilation and heating. The vessel, which was described in our June 23rd issue, has a length between perpendiculars of 350ft, a breadth moulded of 52ft, a depth moulded of 27ft and is propelled by twin screws, driven by two sets of single reduction geared turbines. They develop a total of 12,500 s.h.p., to give the ship a speed of 22 knots and take steam at 312 lb per square inch pressure and a temperature of 670 deg. Fah. at the superheater outlets from two oil-fired Yarrow boilers.

A smaller passenger and cargo motor-ship, is the "St. Ninian," which, as shown in our illustration, presents a pleasing profile, and built for service between east Scottish ports and Orkney and Shetland, and carries passengers, mails, general cargo and livestock. Portable cattle stalls are provided aft in the upper 'tween decks and holds. Accommodation is provided for 160 first-class passengers on four decks and in addition to the usual public rooms there is an enclosed observation saloon arranged at the forward end of the promenade deck. Second-class passengers, numbering 124, are comfortably housed on three decks. The main propelling machinery consists of two sets of British Polar engines developing a total of 2560 b.h.p., at 250 r.p.m., to give the ship a speed of 15 knots.



Medomsley Steam Shipping Company's "Langleeclyde"

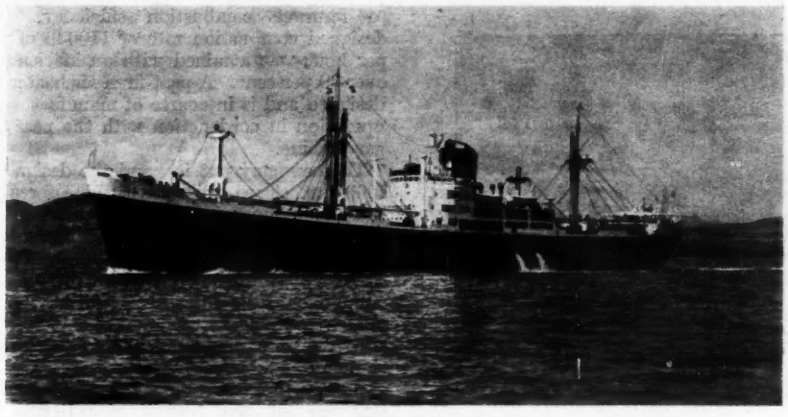
Cargo Liners

The "Rio Bermejo," as illustrated in Plate No. 9, was built by Alexander Stephen and Sons, Ltd., for the Argentina Flota Mercante del Estado, for service between the Argentine, United States and European ports. Her dimensions are 460ft in length, 62ft in breadth, 38ft in depth and she is designed to carry 8300 tons deadweight on a load-draught of 25ft 6in. There are five holds, with a bale capacity of 514,000 cubic feet, including 71,000 cubic feet of insulated cargo and they are served by 10-ton derricks, supplemented by a 30-ton lift heavy derrick. A fully loaded sea-speed of 15 knots is maintained by an 8000 b.h.p. Sulzer diesel engine, constructed by the shipbuilders, which gives the ship a speed of 18¼ knots in the ballast condition.

Clan Line Steamers, Ltd. added the "Clan Sinclair," shown in our illustration, to its fleet, during the year, for its services to the African and Indian ports. The principal dimensions of the vessel, built by the Greenock Dockyard Company, Ltd., are: length between perpendiculars 476ft, breadth moulded 66ft, depth moulded 40ft 8in, and the ship is designed to carry a deadweight of 11,000 tons at a sea-speed of 16½ knots. The vessel is noteworthy in that 10,340 s.h.p. is concentrated in a single shaft. Parsons Marine Steam Turbine Company, Ltd., constructed the double-reduction geared turbines, which consist of three turbines working in series and are of the all-reaction design for ahead duty. Two oil-fired water-tube Babcock and Wilcox single-pass boilers, with integral superheater, tubular preheater and desuperheater, operate under Howden's forced draught and supply steam at 450 lb per square inch and 750 deg. Fah.

An engraving on this page illustrates the "Langleeclyde," which was built by the Blythswood Shipbuilding Company, Ltd., for the Medomsley Steam Shipping Company, Ltd. This shelter-deck vessel, which is of high cubic capacity, carries a deadweight of 10,550 tons and has the following dimensions: 486ft long by 62ft 6in beam by 41ft 6in to the upper deck. The cargo arrangements are designed for rapid handling and a special derrick is provided for heavy lifts. The main machinery, which consists of a Barclay Curle-Doxford oil engine, develops 6800 b.h.p. on service and on trial a mean speed of 17 knots was obtained.

(To be continued)



Clan Lines "Clan Sinclair"

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

GUARDS FOR COUPLINGS AND ASSOCIATED SHAFTING

B.S. 1649 : 1950. This new standard will be of interest and value to all those who are concerned with preventing accidents due to rotating parts. In this new standard, which takes note of the Factories Act, 1937, and has been prepared with the co-operation of the Engineering Branch of the Factory Department of the Ministry of Labour and National Service, general requirements have been laid down for guards which should be applied to couplings between units such as a motor and a pump, and also guards that are required for a length of shafting and coupling. Attention is drawn in the foreword to certain features of the regulations dealing with the provision of safety requirements. The specification itself lays down the necessary requirements to ensure that a guard will have sufficient strength and be suitable for its purpose. In addition, one appendix shows different forms of guards and a second appendix gives recommendations for the responsibility of provision of guards. Care has been taken not to define the guards in detail, thus avoiding restriction in design. Price 2s. post free.

Gas Turbines in 1950

No. I

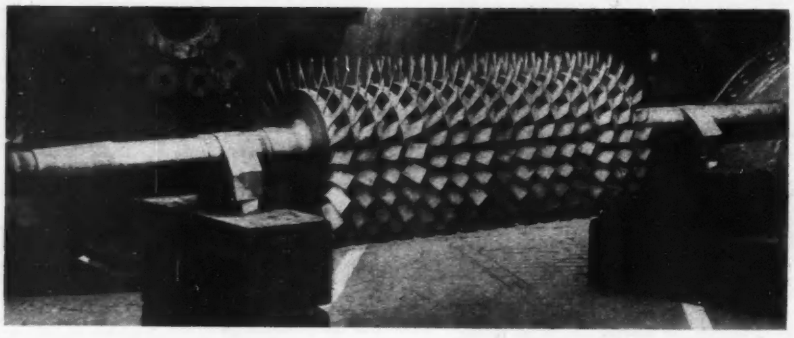
IN the design and construction of gas turbines as prime movers for ship propulsion, problems still exist which are difficult of solution. They relate to the subject of creep, the ultimate failure of metals when associated with the high temperatures considered essential for efficiency, and the relationship between the point at which failure occurs and the life of the turbine, which is required to be 100,000 hours. Other factors which are linked with economics are involved; they include the high degree of reliability which must be attained, maintenance costs and the ability to burn residual fuels. Associated with the latter problem is the difficulty of removing the vanadium compounds which, although they do no harm at ordinary temperatures, foul the turbine blades at normal gas turbine temperatures.

One of the controversial questions relates to the merits of open and closed cycle systems and Mr. J. B. Bucher read a paper, dealing with this subject, entitled "Experimental Running of Open and Closed-Cycle Gas Turbines," before the Institution of Engineers and Shipbuilders in Scotland, on January 24th. He mentioned the main advantage of the closed cycle which is that only clean, dry air passes through the turbine and so no fouling takes place. Tests on an open-cycle turbine were described, the effect of different fuels noted, and the conclusion drawn that difficulties would occur with any fuel other than distillates. The same turbine was modified for closed-cycle operation and an examination after initial trials showed that no deposits had formed and that there was no measurable difference in the compressor performance.

In his paper entitled "Some Factors in the Use of High Temperatures in Gas Turbines," presented to the Institution of Mechanical Engineers" on January 27th, Dr. T. W. F. Brown mentioned that the present working temperature of gas turbines was 1200 deg. to 1250 deg. Fah., and that, with higher temperatures of the order of 2200 deg. Fah., the stressed parts would have to be cooled by either water or air. This could be by either boundary layer cooling or sweat cooling, involving the use of porous materials through which air could percolate. The author considered that air compressors would not be affected by the higher temperatures, but the combustion chamber would require refractory linings which would be of assistance if heavy fuels were burned. With regard to the turbine parts it was suggested that ceramic or ceramal materials could be used, and that rotors of normal heat-resisting alloys should be employed incorporating water cooling or air cooling by either of the two methods previously mentioned.

The year was one of steady progress in the construction of a number of gas turbines, both in the shop and on site, but no machine was actually completed so that the building and testing of parts formed the main items in the year's work of the majority of companies.

Many firms were engaged on gas turbine research during the year, including experimental work connected with the burning of peat, methane and various grades of coal; units were being built for land stations, and for future installation in merchant and naval vessels.

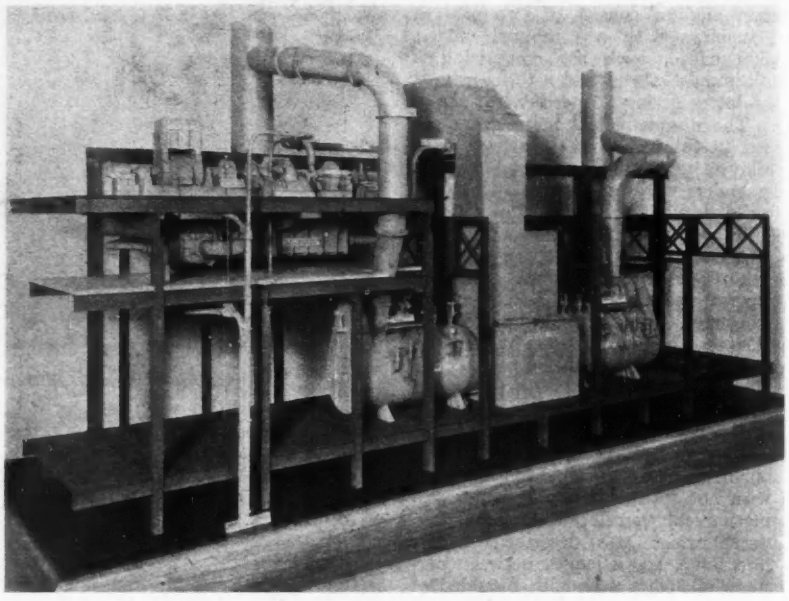


L.P. COMPRESSOR ROTOR FOR 12,500KW GAS TURBINE

JOHN BROWN AND CO., LTD.

During the year the various parts of an experimental unit, which completed 1000 hours' running as an open-cycle unit and 250 hours on a closed cycle, were examined at the works of John Brown and Co., Ltd. Apart from eroded compressor blades and fouling in the gas side of the heat exchanger, the plant was found to be in good condition. After replacing the original Duralumin compressor blades by blades of stainless iron, and brushing through the heat exchanger, the unit was run for 1000 hours on a closed cycle using distillate fuel. An examination after opening up showed that no defects had developed and the plant is at present being reassembled in preparation for tests using heavy fuel.

Considerable progress was made in the construction of the 12,500kW closed-cycle gas turbine for the North of Scotland Hydro-Electric Board's power station at Carolina Port, Dundee, and it is expected to be in service in 1951. The accompanying illustration shows the fully bladed l.p. compressor rotor.



MODEL OF 700KW CLOSED CYCLE GAS TURBINE

Work on the peat-fired gas turbine continued during the year, and tests on the combustion chamber and peat-drying equipment were carried out. In recent months the peat combustion and drying rig were put into operation and modifications made to improve combustion efficiency. The designed combustion rate of 1100 lb of peat per hour was attained with an efficiency of over 90 per cent. A peat-fired air heater was designed and is in course of manufacture for operation in conjunction with the peat fired gas turbine.

The company put in hand the design of a 1000 h.p. closed-cycle gas turbine for a life of 100,000 hours, to work in association with the coal-fired air heater which it designed at the request of the Ministry of Fuel and Power. This unit is now being manufactured and will go on test this year. Initially, good-quality coal will be used and it is planned to add a drying plant to enable coal slurries to be burned.

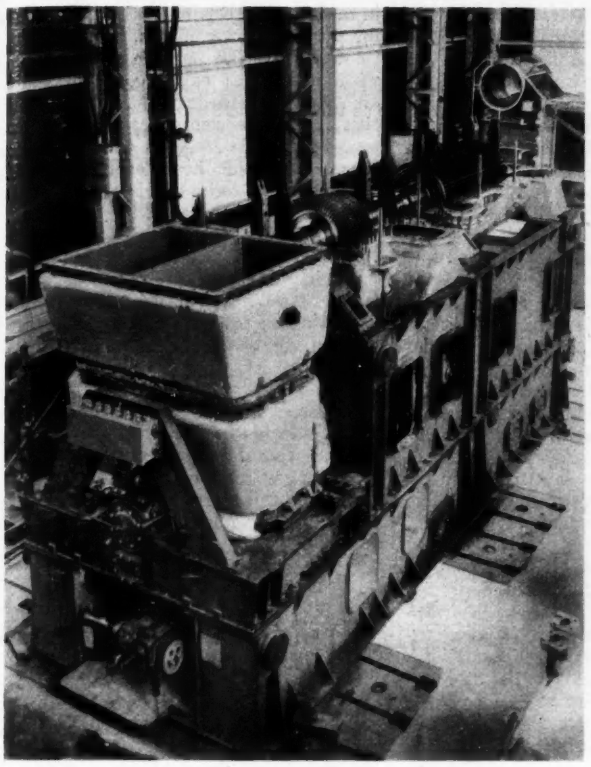
Steady progress was made with the construction of the 700kW closed-cycle gas turbine, for the utilisation of waste heat from a carbonising plant, ordered by Spencer Bonecourt, Ltd., for installation at the Foleshill gas works at Coventry, and our illustration shows a Bassett-Lowke model of this plant.

BRITISH THOMSON-HOUSTON COMPANY, LTD.

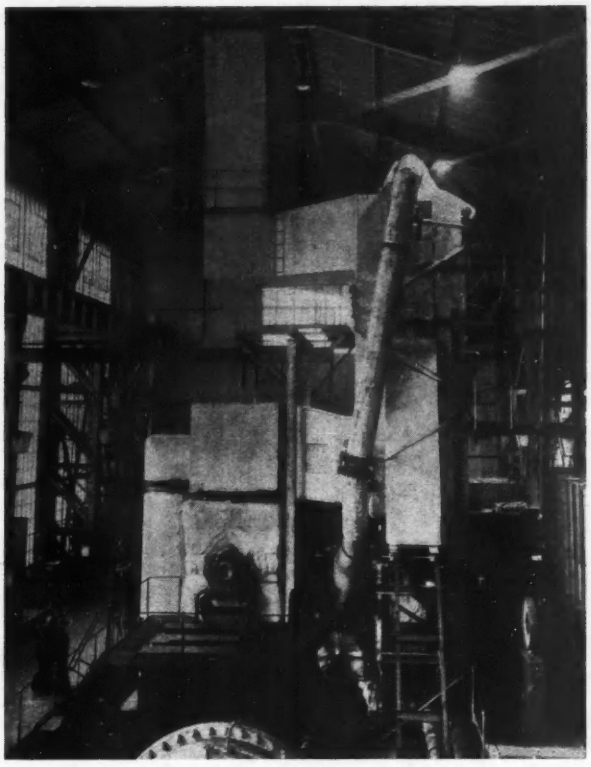
Satisfactory progress was made during the year by the British Thomson-Houston

Company, Ltd., on the construction of the two 2500kW gas turbine alternator sets ordered by Balfour, Beatty and Co., Ltd., for the East African Power and Lighting Company, Ltd. These turbines are single-cylinder, open-cycle machines, each of which has a heat exchanger, a single combustion chamber and a centrifugal compressor incorporating the Oerlikon diffuser system.

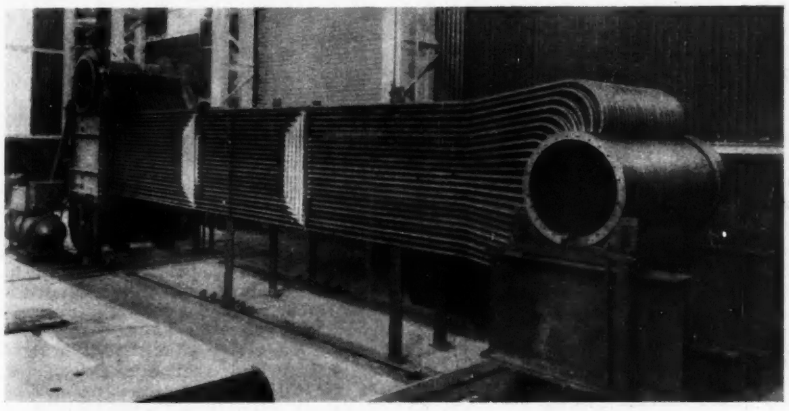
In 1951 it is hoped to install a gas turbine in the M.S. "Auris," which is a 12,000-ton oil tanker in the fleet of the Anglo-Saxon Petroleum Company, Ltd. This vessel was built some two years ago and with the idea of conversion, provision was made for fitting and testing a gas turbine unit. The existing propulsion machinery consists of four Hawthorn-Sulzer eight-cylinder, single-acting, airless-injection, supercharged oil engines, each of 1105 b.h.p., direct coupled to B.T.H. double-unit 880kVA alternators. One oil engine will be replaced by the 1200 b.h.p. marine gas turbine electric set (shown under construction in our illustration), which completed a number of tests during the year. The plant operates on the open-cycle system, is equipped with a heat exchanger, and consists of two turbines in series. The h.p. turbine drives the compressor, while the l.p. turbine drives the 880kVA alternator to provide power for the propelling motor. In another illustration is shown the heat exchanger in which the exhaust gases flow longitudinally outside the tubes and air from the compressor flows inside the tubes to outlet headers in which the combustion chambers are fitted.



"AURIS" GAS TURBINE



3500 H.P. GAS TURBINE



HEAT EXCHANGER TUBE STACK FOR "AURIS" GAS TURBINE

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

Detail modifications were carried out to the 2000kW gas turbine geared alternator set installed at the Trafford Park works of Metropolitan-Vickers Electrical Company, Ltd., and additional operational experience was gained. The gas turbine unit, which is under construction for a locomotive, was subjected to extended bench tests and the spray cleaning equipment, which was designed to clean compressor blading without dismantling, was nearly ready for testing by the end of the year. It is expected that the locomotive will undergo running trials this year.

Considerable advance was made in the construction of the 15,000kW gas turbo-alternator set which was ordered by the British Electricity Authority for the Trafford generating station. Erection work was started and the heat exchanger and inter-cooler were installed. The heat exchanger consists of six units operating in parallel with exhaust gases inside and air outside the tubes, and our illustration overleaf shows three of these units in course of manufacture.

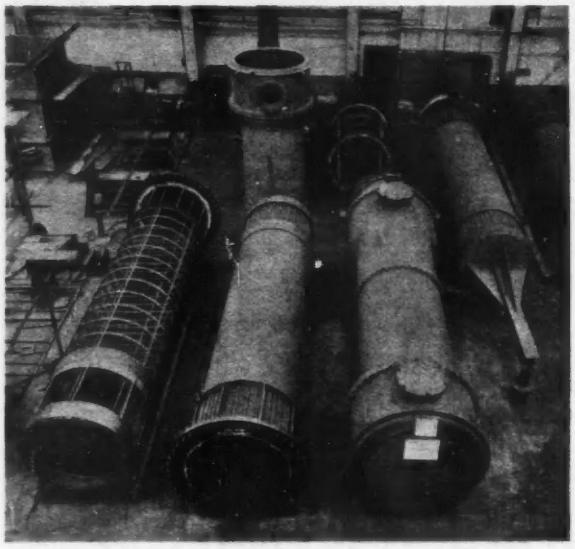
During the year, work proceeded on the 2500kW set being built for the Metropolitan Water Board and the 1750kW set for Shell Petroleum Company, Ltd. The 2500kW gas turbine is intended for standby duties and will burn gas oil, while the 1750kW unit is designed for base load running and will use natural gas as fuel.

Another contract which the company has in hand is a 2000kW gas-turbine geared alternator set, ordered by the Ministry of Fuel and Power. This machine will be generally similar to the gas turbines under construction for the Metropolitan Water Board and the Shell Petroleum Company, Ltd., and will operate on producer gas.

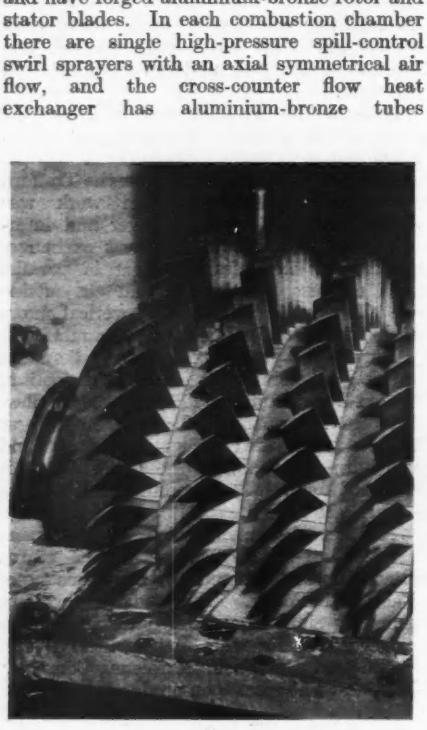
PAMETRADA

As recorded in our issue of June 16th we witnessed a demonstration of the Pametrada 3500 h.p. open-cycle experimental gas turbine which was specially designed for a merchant ship and built up of parts supplied by the constituent firms

and supervised by Lloyd's. During the year exhaustive tests were carried out with the object of remedying any faults, effecting improvements before installation on board ship, and studying gas turbine problems generally. The turbine, as erected, is shown in our illustration. Alignment and expansion problems were treated as for an actual ship installation. The high-pressure turbine, the two compressors and the starting turbine were mounted on a girder strong enough to withstand the working of a ship. The two multi-stage axial-flow compressors were designed for maximum efficiency at full load and have forged aluminium-bronze rotor and stator blades. In each combustion chamber there are single high-pressure spill-control swirl sprayers with an axial symmetrical air flow, and the cross-counter flow heat exchanger has aluminium-bronze tubes through which compressed air is passed while the hot gases pass outside in the opposite direction. High-pressure and low-pressure turbines are of double-flow design and two fluid couplings on the shaft of the output turbine meet the requirements of ahead and astern running.



HEAT EXCHANGERS FOR 15,000kW GAS TURBO-ALTERNATOR SET



COMPRESSOR ROTOR BLADES

C. A. Parsons and Co., Ltd.

The firm of C. A. Parsons and Co., Ltd., was busy during the year erecting in the shops a 15,000kW gas turbo-alternator for the Dunston "A" power station, and a 10,000kW gas turbo-alternator for the National Gas Turbine Establishment. All the information gained from five years of research and from practical experience has been incorporated into the design of a new gas turbine which the firm began to manufacture during the year. It is considered that the design of this turbine, which has a net output of 2500kW, will form the fundamental basis upon which future machines will be modelled. The size of the new turbine makes it particularly suitable for export purposes, because the costly handling of large components will be avoided, and also the necessity of building extensive foundations. Another field of research, which engaged the attention of the company during 1950, was the problem of developing methods of burning coal and peat in gas turbines and it worked in association with the Ministry of Fuel and Power upon those projects.

Ruston and Hornsby, Ltd.

The gas turbine made by Ruston and Hornsby, Ltd., was demonstrated early in 1950, and since then the running time has exceeded 1000 hours, during part of which the alternator was connected to the national grid. Early developments were concerned with perfecting combustion, and modifications to the flame tube resulted in a clear exhaust. Cracking of fuel in the atomisers after the turbine was shut down was an initial trouble as the cracked fuel tended to block the internal passages in the atomiser on restarting. The atomiser which was eventually developed can operate for long periods in preheated air without deterioration of the fuel spray, and the design is such that it is positively cooled by fuel after the plant is shut down, so overcoming the original defect. In the epicyclic reduction gear associated with the turbine, the replacement of the sunwheel by one of harder material resolved wear troubles with their resulting increased noise, and after 800 hours' running the backlash was unchanged.

The effect of dirt upon the axial compressor performance was studied and tests showed that the blading in use was relatively insensitive to the accumulation of dirt. Bearing oil drawn into the compressor caused a considerable increase in the rate of deposition of dirt, but only a slight reduction in efficiency. The accompanying illustration shows the blades after endurance running. The deposits on the blading tended to reach equilibrium, after which the efficiency was practically unchanged for a long period, a fact which went some way to remove doubts concerning the effect of blade fouling upon the efficiency of small axial compressors.

The thermodynamic performance of the heat exchanger was satisfactory and no measurable drop in efficiency occurred due to fouling of the tube surfaces, although there was some corrosion at the gas inlet end of the tube bundles. This was traced to brazing flux not removed by pickling and a mechanical method of tube fixing will be adopted in future. The Ruston gas turbine is suitable for portable power plants, so tests were run to determine the performance of the plant without its heat exchanger, and additional air was passed through the primary combustion zone to accommodate the combustion temperature rise. After the completion of these tests the heat exchanger will be replaced and a series of trials run using heavy fuel with a high vanadium content, and metallurgical examinations will be made of the effects of any deposition.

During the year research was continued into the problems of using peat as a fuel. Encouraging results were obtained in combustion rig tests and useful data collected concerning the handling, pulverising and injecting of peat into the combustion chamber. The design of exhaust-drying arrangements to enable the turbine to operate on fuel containing up to 80 per cent by weight of water was well advanced and a prototype will be incorporated in the 750kW gas turbine which will undergo full-scale tests this year.

(To be continued)

Electricity Grid Control Centre in Paternoster Square

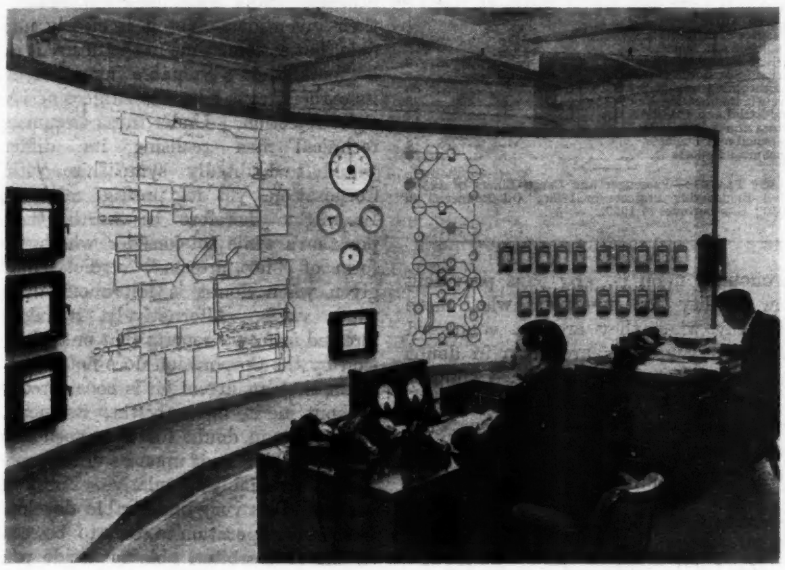
Control of the British grid, operated as an interconnected system, is carried out from eight area control centres at Glasgow, Newcastle, Manchester, Leeds, Birmingham, London (two centres), and Bristol. Each of these control centres is responsible for the operation of the lines, substations and associated generating stations in the control area. Overriding control over the area control centres is exercised by a national control centre, which is responsible for general security of supplies, economic transfers of energy between areas, system frequency and electric time. The national control centre and one of the two London control centres were, until recently, in the former Central Electricity Board control centre in Newgate Street, E.C.1. The other London control centre was in the former London Power Company building in Horseferry Road, Westminster. Owing to congestion and increasing obsolescence of indication and communication equipment, it has become essential for the control centres to be moved and, as a permanent building is not yet available for them, temporary accommodation has been built in Paternoster Square, E.C.1, where the centres were formally opened last week.

National Control Centre

National control in London has no concern with the operation of individual generating stations or grid equipment; its function is the general co-ordination of interconnected operation through the area control centres at Glasgow, Newcastle, Manchester, Leeds, Birmingham, London and Bristol. Within the limits of security and tie-line capacity, operation of the British grid system is on an economic basis, and one of the main functions of national control is to arrange transfers of energy between areas to obtain the maximum use of high merit generating plant. Inter-area transfer programmes are arranged in advance each week in the light of the latest information on plant availability, relative generating costs and expected demands in each of the areas. The programmes are reviewed, and if necessary revised, at regular intervals each day to take account of actual conditions. There is a wide range in fuel cost per unit between the most and the least economic generating stations in the country, due to the different sizes of machines,

steam pressure and other operating conditions, age of plant and cost of freightage of coal. There is, therefore, scope for substantial savings by transferring energy from the cheaper to the dearer regions of the country.

Another of the responsibilities of national control is the co-ordination of main transmission line and generating plant maintenance programmes. At present another important function of national control is the sending out of load shedding instructions to the areas, if the demand for electricity at a particular time exceeds the capacity of the generating plant available or if there is a risk of overloading grid circuits due to uneven distribution of demand over the network. Load shedding instructions are timed to prevent the frequency falling below 48 cycles per second. To help him to anticipate changes in frequency the national control engineer makes use of a rate-of-change-of-frequency meter alongside the frequency meter on his desk as illustrated.



BRITISH ELECTRICITY AUTHORITY'S NATIONAL CONTROL ROOM

The information required by national control is displayed on a curved panel which forms one side of the room. The panel, part of which is shown in our illustration, carries a diagram of the complete grid system on which the national control engineer marks up any lines which are out of service for maintenance or due to breakdown, and from which he can see what lines are available to carry energy from one part of the country to another. A simplified diagram on the panel shows the inter-area lines only, but with meters mounted on each line to show what power is being transmitted between areas. The panel also embodies frequency meters, clocks, time error recorders and chart recorders to provide a permanent record of various quantities.

Eventually part of the panel will be occupied by a diagram of the 275kV grid on which the position of each circuit breaker will be indicated automatically. Adjacent to the national control room is a teleprinter room with instruments for sending messages and instructions to the eight area control centres.

Area Control Centres

When the control centres were moved to Paternoster Square opportunity was taken to rearrange the original control areas into two more nearly matched parts, so that the most efficient use could be made of the existing equipment and staff. The area covered by these two control centres is known as the Thames control area and stretches from the Wash to Littlehampton. The dividing line between the north and the south of the area follows mainly the route of the River Thames. Each area control centre is connected with national control by teleprinter and separate operating instructions are received by this means. Each control centre also has private telephone lines direct to all generating stations and grid substations in its area.

The two main functions of the grid control engineer are switching of grid circuits and loading of generating stations. These functions are carried out with the aid of diagrams and instruments suitably arranged in relation to the control desks. The switching diagrams show every circuit and item of equipment over which the grid control engineers have direct control. No direct switching is carried out from the control rooms; telephoned instructions are used exclusively. All switching is done in accordance with the British Electricity Authority safety rules under a very complete "permit-to-work" system, the final arbiter in all cases being the control engineer. The loading diagrams show the grid system in outline and, for simplicity in operation, instruments indicating the power flow in the lines and other important information are incorporated in the diagrams.

Each loading desk is provided with a "routine instructor" instrument, by means of which instructions can be sent out (merely by operating the appropriate switch) to the more important generating stations. These instructions cover the picking-up or dropping-off of specific amounts of generation or the shedding of load. Stations not connected to the routine instructor are contacted by telephone. In each area control room there is a reproduction of the national control diagram, which is kept dressed from information received over the teleprinter service. The area control engineers are thereby aware of conditions elsewhere in the country which may affect their own operation. Each of the miniature national control diagrams has a background of metal-faced plywood and small permanent magnets are used as markers for indicating line outage conditions.

There are two principal differences between the lay-outs of the two control rooms. First, in Thames North the loading and switching diagrams are placed at opposite ends of the control room. This arrangement makes for quietness when a number of telephone calls are in progress, as it gives maximum separation of the control desks. It has the disadvantage, however, that the switching engineers have their backs to the loading diagram, to which they may wish to refer from time to time. This disadvantage has been overcome in the Thames South control room by placing the loading and switching diagrams in one continuous line.

Secondly, in Thames South the switching diagram is a temporary one of plywood with plastic discs representing switch and isolator positions. The circuits are represented by suitably coloured adhesive tape; similar tapes are also used for the loading diagrams in both control rooms. In Thames North the switching diagram has been brought from the previous control centre and re-erected. It comprises approximately 40,000 1in squares of plastic material mounted on vertical steel strips 6in wide with a choice of different symbols engraved on the squares and suitably coloured. Provision is made for fixing labels to indicate the presence of earths on apparatus under maintenance. Labels are also used to show apparatus covered by "permit-to-work" cards and to signify special requirements.

Lloyd's Register Annual Report

THE Lloyd's Register of Shipping annual report for the year ended June 30, 1950, is the first since the amalgamation with the British Corporation the last being published twelve years ago. Referring to the effect of world conditions on shipping the report says that compared with the easy optimism following World War I realism has been the keynote after World War II, and it considers that the present fleet is a more efficient instrument of commerce than that of 1939. The distribution of tonnage has changed and America has the highest total under one flag, but Britain has the largest fleet in active employment. Changes in various committees, consequent upon the fusion of the two societies, are recorded and also the fact that the Technical Committee has been enlarged to include representatives of shipbuilding, marine engineering and allied industrial organisations and technical institutions. Five liners are listed among the ships completed to class, and also 85 ships fitted with refrigeration plant. The 2,042,428 tons gross of ships built to Lloyd's Register classification represents an increase of 25 per cent over the preceding year, and includes 791,743 tons of oil tankers. This increase resulted in more load-line assignments made on behalf of Governments which are signatories of the International Load Line Convention. Classed tonnage is given as 9600 ships of 34,500,000 tons gross, representing about half of the effective world total. Work in hand to Lloyd's Register class at June 30, 1950, amounted to 543 ships of 28,460,000 tons gross, marine engines of 2,200,000 s.h.p., electrical installations of 130,000kW, and refrigeration plant for 11,000,000 cubic feet. With reference to steel testing, the report states that at 1,351,992 tons the amount tested was 10 per cent greater than for the previous year, and that there are 123 steel works in Great Britain and 323 abroad, which are recognised by the Committee. Trends in design are discussed and the steady increase in size of ships is noted, particularly of tankers, in which the standard of 12,000 tons deadweight has been replaced by vessels of 18,000 tons and tankers of 30,000 tons are under construction. All classes of cargo ships have increased in speed and the shelter deck design has superseded the poop, bridge and forecastle vessel. The report goes on to state that better gear-cutting technique, together with higher steam pressures and temperatures, which result in greater cycle efficiency, have been responsible for the increasing use of geared turbines for powers in excess of 8000 s.h.p. The Scotch boiler has retained its popularity and the established design of natural-circulation, water-tube boiler has continued in demand. Brief mention is made of the gas turbine, of atomic energy and the possibilities of a.c. or d.c. systems. A number of interesting tables are included in the report. Age distribution of tonnage shows the steady increase in the percentage of ships over twenty-five years old from 13 to 20 per cent, and flag distribution indicates the relative decline in British-owned tonnage and the rise in the total of American vessels. A graph shows the tonnage completed and classed annually over the last thirty years. A propulsion analysis table covering a period of twenty five years indicates clearly the recession of the reciprocating engine, the remarkable rise in favour of the oil engine, and the increasing popularity of the steam turbine.

THE ENGINEER

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JUDGMENT UPON INVENTIONS

UNDER the Development of Inventions Act, 1948, the Board of Trade was authorised to set up a National Research Development Corporation, with the objects of securing the development or exploitation of inventions and of acquiring, holding, disposing of or granting rights in such inventions. The Corporation so authorised came into being on June 28, 1949 and, as we noted in a Seven Day Journal note last week, it recently issued a report on its first year of operation to June 30, 1950. That document is one that all bodies and all individuals who may contemplate placing inventions in the hands of the Corporation should read. For it forms in effect a statement of the manner in which the Corporation intends to set about its task. We say "intends to set about its task," because, although some 965 inventions were submitted to it during the year, of which 363 were rejected, the Corporation had hardly begun its real work. The year was as much spent upon considering how it was to operate and upon the creation of an organisation as upon the consideration of the merits of the inventions submitted. For the members of the Corporation, under their chairman, Sir Percy Mills, needed to study what bodies could be expected to submit inventions, how the merits of those inventions could be assessed, what principles were to guide them in their decisions about their development and exploitation and what the relations were to be between the Corporation, inventors and manufacturing firms. That work, the Report reveals has been well and wisely done.

It now remains to be seen, after so good a start in clearing the ground, how the Corporation will get on and what reputation it will earn. It provides for inventors, whether they are members of the public, workers in Government or industrial research bodies or University research men, the positive advantage that it can ensure that any invention is quickly submitted for judgment of its value to those prominent in the particular field with which it is concerned and therefore well-fitted to pronounce upon it. By thus providing a new facility for inventors, who, more particularly when they are not connected with any organisation, are often in doubt as to whom to approach for advice, support and assistance, the Corporation will be doing more satisfactorily than heretofore what formerly was done in a more haphazard manner by many firms, private consultants, &c., and not least the technical press. Indeed the Corporation will be able to go much further, in that it can make and is in fact intended to make quick provision for the further development and/or the immediate exploitation of an invention once its value has been assessed. In by far the majority of cases, too, the judgment reached by the experts to be consulted is likely to be sound and, no doubt, the Corporation will reject or develop and exploit an invention in accordance with the views expressed. But experts, being human, are sometimes fallible, even in their own fields. Nor is the value of inventions, as originally conceived, always easy to assess. Had, for instance, the Corporation been in existence at the critical time, what technical advice would it have received about the value of the Hon. C. A. Parsons' project for a steam turbine? What decision would it have reached about the prospects of the Humphrey pump? Would it have spent money upon the development of the "Never-Stop" railway? How would it have reacted to Sir Harry Ricardo's proposal for ship propulsion with multiple small horsepower internal combustion engines? There is no lack of examples of proposals that upon the one hand generated considerable technical enthusiasm at first but were found upon trial able to achieve little, and upon the other hand of those which, heavily criticised at birth, later proved successful. More than one inventor, in fact, has triumphed later in the end over those expert in his field who decried the merits of his invention. It is true that a far larger number, defying informed criticism, have struggled hopelessly on, expending time, money and energy on devices that never could come to fruition. But what line is the Corporation going to take when it is in doubt or when expert opinion is divided? It is a point not without importance because, for all its very real value, the Corporation might easily provide in future an additional obstacle for an inventor, of real but unrecognised talent, to surmount. For what firm or what organisation is going to expend money on the development of an invention if it has suffered rejection by the Corporation?

The Corporation, where there is any doubt about the merit of a proposal has clearly a heavy responsibility to carry. It is true that rejection by the Corporation is very unlikely to stop the majority of enthusiastic inventors from continuing to work upon their inventions. Yet it is clearly undesirable that at some time in the future it should be found that a valuable invention had in its earlier stages been the subject of its outright rejection. Under those circumstances technical men realising its difficulties would undoubtedly sympathise with the Corporation, yet its prestige might suffer. It might therefore be worth the Corporation's while to consider whether some form of "not proven" verdict could be given when doubt is felt about an invention's value. Alternatively, it might be stressed in future reports that outright rejection by the Corporation does not necessarily mean that an invention is considered to be without merit, but only that its merits are sufficiently in doubt for the expenditure of limited public funds upon its development to seem unjustifiably speculative. For it would, we think be a very undesirable development were the Corporation to come to be regarded as the final arbiter, able to decide whether or not an invention should or should not be developed and exploited. That is not the function it was set up to perform.

MECHANICAL HANDLING

IT has been recognised by many of the "Productivity" teams that have visited America that the mere issue of a report is not enough. Other means must be found to preach the "gospel" if all those who may learn from it are to hear it. One of those means is to organise conferences or meetings at which the report itself can be discussed and at which, in particular, members of the teams can express in person their impressions of America and their convictions as to what ought to be done by industry here. Last Friday the Institutions of Mechanical and Electrical Engineers, following such a plan, met jointly in the hall of the former to discuss a paper by Messrs. Roebuck, Carnegie and Taylor on "Mechanical Handling," which was based upon the report, issued last October, of a productivity team led to America late in 1949 by Mr. Roebuck. The three authors of the paper were the nominees of the two institutions to the team and several other members of the team contributed to the discussion.

It is a natural and unavoidable weakness of such meetings that they tend to attract predominantly those who have already been "converted," with the result that the subject is not so much discussed as the "gospel" further preached. Last Friday's discussion was not free from that fault. Yet, either directly or implicitly, a number of interesting points were made. It was emphasised, for instance, that British-made materials hand-

ling equipment is fully equal technically to the American and also—it is a fact not fully appreciated by industrialists in this country—that there is no item of plant made and used in America that is not also made and used here. As the members of the team went from place to place in America, seeing, in the words of their report, "a cross-section of warehousing, of light and heavy manufacturing in both jobbing and mass-production factories, and the loading and unloading of rail and road vehicles" they, thus, thought at first they were seeing nothing new. But as time passed they became more and more impressed by the intensity of the usage of handling equipment, the manner in which every opportunity was seized to use it, the fact that all Americans, managements and men alike, tended to think in terms of mechanical rather than man handling, and the way in which many companies had set up special departments to study the subject continuously. Here, besides an intensity of usage foreign to all but a few advanced British firms, was an attitude of mind towards the subject different from that found in Britain. Unfortunately, the discussion did little to reveal why the situation in Britain should differ so much from that in America. Several answers were, indeed, directly or implicitly, suggested in the discussion. But none was wholly satisfactory. One speaker, for instance, complained that though British managements were getting much less than 100 per cent usage of machine tools, they often inconsistently insisted that they should have 100 per cent usage of such equipment as fork-lift trucks, and went without if they could not. It was further suggested that many British firms just did not know what large tonnages of materials had to be moved in their factories nor what equipment was available to move it; that many managements failed to study handling problems sufficiently; that they failed to call upon specialists for advice; that they tended to install equipment piecemeal instead of studying the needs of the works as a whole; and that they did not always install the right equipment. But for ourselves we doubt whether those indictments of British industry give a wholly fair impression.

There is, of course, some truth in the criticisms that were raised in the discussion. We think, indeed, that more attention might well be given to the study of materials handling in many factories in this country than is given to that subject. Yet there seem to us to be reasons why the Americans can be expected to be leading this country in the application of materials handling plant. There is, of course, the obvious fact that concentration of production for war purposes temporarily held back the normal development of production methods for peace in this country. Firms here have, therefore, to catch up; and in fact very many of them are now installing or are planning the installation of improved handling plant. Some delay is, however, imposed by the fact that expenditure of capital is needed for the installation, capital that may not be immediately available. Further delay may be imposed by the expiry of time between the giving of an order and delivery. Hindrance, too, may be imposed by the need to economise in the use of power. Again, upon another tack, it cannot too often be emphasised that economic conditions here and in America are not the same. Before a project for the use of mechanical handling plant can be adopted a hard-headed calculation has to be made as to whether it will pay. That calculation will not always give the same answer in this country as it does in America, where wages are higher, skilled men fewer, and standardisation, simplification and specialisation can be, and have been, carried further. There is, too, the further factor that labour in this country still retains strong memories of the misery of widespread unemployment during the 'thirties and tends to regard the extension of "labour-saving" devices with a jealous eye. What is the use of installing cranes, conveyors and fork-lift trucks if the trade union involved insists that as many men as before must continue to be employed? That is a problem in labour relations that can be solved more easily in expanding industries, in which work for those displaced can be found elsewhere, than in non-expanding industries, such as dock work. But it is often troublesome. All such factors have to be weighed up, and if the answer reached does not always satisfy those who can see only the advantages of mechanical handling or of other methods of increasing productivity, that does not necessarily mean that it is the wrong one. After all, to judge by recent figures, suggesting a rate of 8 per cent per annum, this country is not doing badly in raising its productivity and keeping down its prices, too! That improvement has not come about solely by copying American methods. It is much more the consequence of studying what methods, whencesoever derived, will best suit British conditions.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

REACTIVE FORCE IN A TURBINE NOZZLE

SIR,—A letter appearing in your issue of December 22nd, over the name of A. C. Hutchinson, attracted my eye, first because I have known him for twenty-five years and, secondly, because the subject about which he writes is closely allied to the occupation by which we both earn our livings.

I must agree with Mr. Hutchinson's answer and reject the Editorial defence as it stands. Unfortunately, one statement is missing, and it is a very important one. Nothing is said about the pressure surrounding the box. The Editorial statement implies that it is not more than 69·3 lb per square inch, but it might be less. If this is the surrounding pressure, then the Editorial figure is reasonably true. If the surrounding pressure is 14·7 lb per square inch, then Mr. Hutchinson's figure is nearer the truth. The Editorial defence seems to ignore the fact that a convergent nozzle can, by a remarkable phenomenon, produce a jet with a supersonic velocity when supplied with a pressure ratio which is larger than the critical one. The difficulty of arriving at an exact figure is because of the uncertainty of the value of the losses due to under-expansion. The results of the experiments by Steinmetz, on the losses due to under- and over-expansion, have been appearing in turbine books for many years.

The points raised in the latter bring back some of the strange discussions, which took place after the propulsion of aircraft by jets first became public.

The reviewer's statement that the reaction is due to the change of momentum is certainly true, but it can also be calculated by multiplying pressures by areas, if one is prepared to calculate the pressures at many points in a fluid which is accelerating and then to apply them to a number of small areas.

I have seen the book which is the cause of this correspondence and there is one thing which it brings out very well. American small turbines have never been noted for their beauty and the authors have certainly succeeded in assembling a galaxy of some of the ugliest. It is a strange contrast with their large turbines, many of which are beautiful.

R. C. MCLEOD

Loughborough,

SIR,—As you stated in your footnote to Mr. Hutchinson's original letter in your issue of December 22nd last, the reactive force of any jet must be equal to the rate of change of momentum of the issuing fluid. The pressures inside and outside the box in the case referred to have, of course, to be taken into account in computing the velocity and, therefore, the momentum of the jet, and Mr. Hutchinson is wrong in thinking that they affect the question otherwise. He is also wrong in assuming, as he does in his first letter, that the reaction of steam at 120 lb pressure escaping through a nozzle of 1 square inch throat area must be limited to 240 lb. With a properly proportioned diverging mouthpiece added to the same nozzle, the reactive force of saturated steam at 120 lb absolute flowing into a vacuum of 29·82in (corresponding to a condenser at freezing temperature) would theoretically amount to about 249 lb.

R. H. PARSONS

January 6th.

LOCOMOTIVES OF 1900

SIR,—I have read the article in your issue of December 29th with considerable interest and, with your permission, would like to comment on two points. The arrival of American-built locomotives in this country is described as a "unique event." This was not an unparalleled happening; it will be recalled that the Birmingham and Gloucester Railway in 1840 had turned to the American firm of William Norris for engines to operate over the Birmingham–Cheltenham route. Some of this type subsequently worked on the Grand Junction Railway.

It is incorrect to say that the 2–6–0 wheel arrangement was unrepresented here, save on the Great Eastern Railway, until the arrival of the engines described in the article. Beyer, Peacock and Co. supplied this type to the Midland and South-Western Junction Railway in 1895 and 1897.

C. R. H. SIMPSON

January 2nd.

BOOKS RECEIVED

Applied Mechanics Dynamics. By G. W. Housner and D. E. Hudson. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 22s. 6d.

Advanced Surveying. Vol. II. Second edition. By W. Horace Rayner. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 33s. 6d.

Garcke's Manual of Electricity Supply. Edited by Frederick C. Garrett. London: The Electrical Press, Ltd., 23, Great Queen Street, W.C.2. Price 63s.

High-Speed Computing Devices. Edited by W. W. Stifler, Junr. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 55s. 6d.

Basic Mathematics of Technology. Vol. I. By J. Chance and G. F. Sims. London: The University of London Press, Little Paul's House, Warwick Square, E.C.4. Price 8s. 6d.

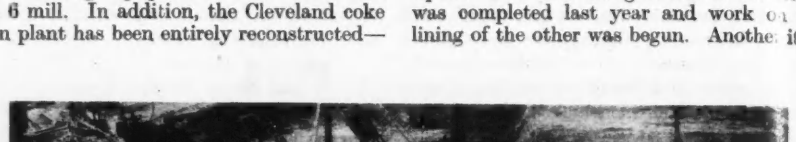
The British Iron and Steel Industry in 1950

No. II—(*Continued from page 19, January 5th*)

AN important part of the steel industry's development plan in the North-East Coast area is that for which Dorman, Long and Co., Ltd., Middlesbrough, is responsible. That company's expansion scheme has been arranged in three stages, the first of which was concerned primarily with additions to and replacement of existing plant at the Cleveland and Redcar works. This first stage was virtually completed in 1949 by the bringing into operation at the Cleveland works of a central ore unloading, ore preparation and sintering plant.

In the autumn of 1949 a start was made on the second stage of the Dorman Long development, which is the construction of a new open-hearth steel plant, with a capacity of 500,000 tons of ingots a year, at Lackenby, a site of 650 acres linking the Cleveland and Redcar works. Much of the work there is being carried out by the Dorman Long group of companies, which report good progress during 1950. The Lackenby plant is to be equipped with four steel furnaces, each of 360 tons nominal capacity, and two 600-ton mixers. Incidentally, the company believes that the new furnaces will be the largest tilting furnaces operating in Europe, and probably larger than any in the U.S.A. During last year the stripper building—illustrated by an accompanying engraving—was completed, and is now in use, temporarily, as a structural engineering shop for fabricating the more massive steelwork needed for the building of the adjoining melting shop, the framework of which is now in course of erection. A great deal of work was also accomplished last year on the foundations for the furnaces and mixers. A view of the furnace foundations, showing the brickwork, is reproduced in one of our engravings.

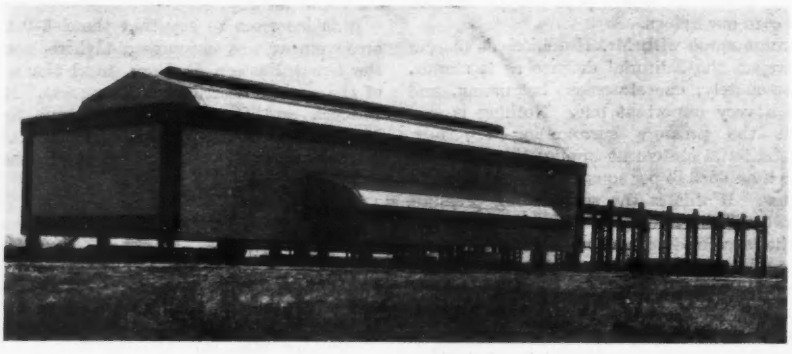
It is confidently expected that the Lackenby works will be in production before the end of 1952. A link railway line between the Cleveland and Redcar works passes through the Lackenby site, and by using special ingot transfer cars it will be possible to convey hot ingots from there either to Redcar or Cleveland as occasion demands. The third stage of the Dorman Long plan provides for the installation of a beam mill at Lackenby and for the construction of some new large blast-furnaces at the Cleveland works. The development plan, it should be noted, envisages the concentration of North-East Coast rail production at the Cleveland works, and initial steps towards that concentration have been taken by Dorman Long and Co., Ltd., by modernising the finishing and handling equipment of the Cleveland No. 6 mill. In addition, the Cleveland coke oven plant has been entirely reconstructed—a task which has occupied two and a half years. This plant is now carbonising 22,000 tons of coal a week.



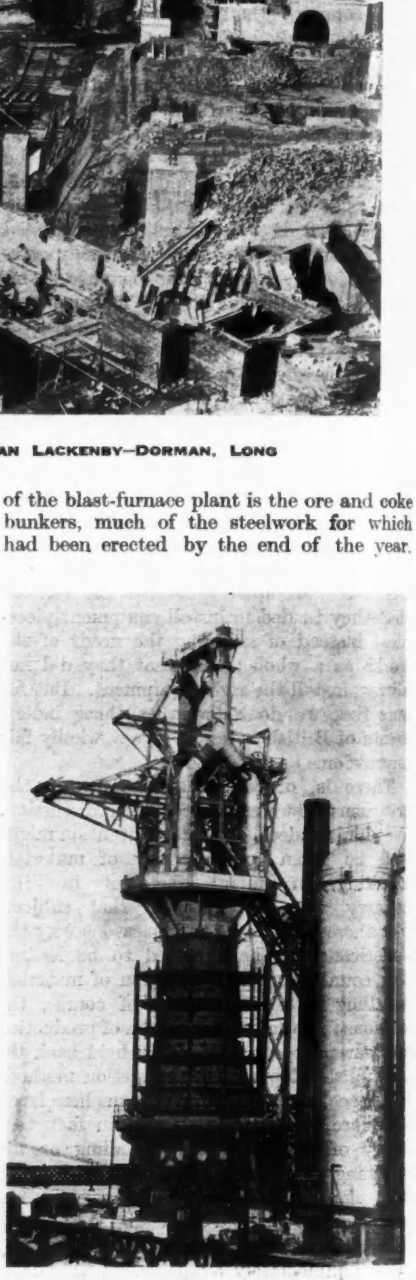
STEEL FURNACE FOUNDATIONS AN LACKENBY—DORMAN, LONG

Another modernisation project in the same area is that which is proceeding at the works of the Skinningrove Iron Company, Ltd., near Saltburn-by-the-Sea. The annual output of these works is at present about 180,000 tons of pig iron, 220,000 tons of steel ingots and 180,000 tons of rolled steel, but the developments in progress, it has been stated, will increase the yearly production to 310,000 tons of pig iron, 315,000 tons of steel ingots and 250,000 tons of rolled steel. The expansion at Skinningrove involves the building of a new blast-furnace, with two hot blast stoves, ore and coke bunkers, and a turbo-blower; the extension of the melting shop to accommodate a 600-ton inactive mixer and a new 300-ton steel furnace; the construction of two additional soaking pits, making seven in all, and the erection of a new ingot stripper. The 18in rolling mill is also to be enlarged.

During last year the structure of the new blast-furnace, including the headgear and the skip hoist, was completed. The furnace, which is shown in an illustration, has a hearth diameter of 21ft, and the lining has now been installed up to the bosh. The two hot blast stoves, each 110ft high by 25ft diameter, are of welded construction and each will have a heating surface of 237,000 square feet. The lining of one of the stoves was completed last year and work on the lining of the other was begun. Another item of the blast-furnace plant is the ore and coke bunkers, much of the steelwork for which had been erected by the end of the year.



STRIPPER BUILDING AT LACKENBY—DORMAN, LONG

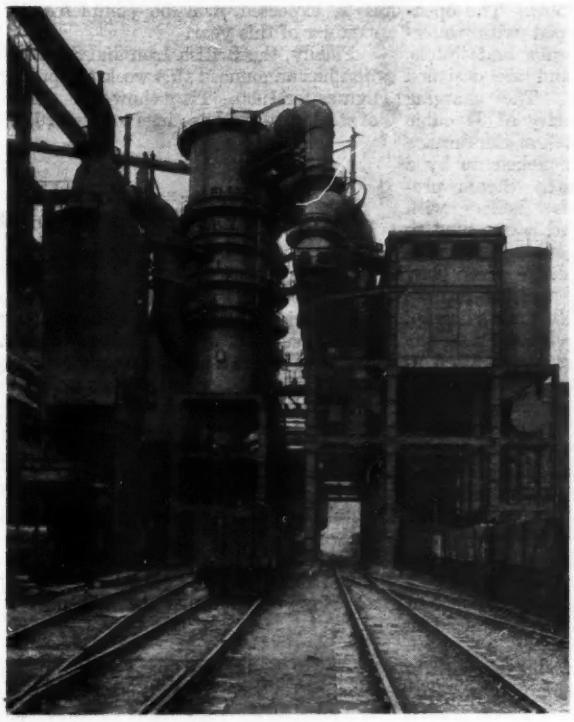


BLAST FURNACE AT SKINNINGROVE

Good progress was also made on the foundation and structural work for the 40-ton wagon tipplers and for the ore crushing plant. In the melting shop the installation

of the 600-ton inactive mixer was completed last February and it has been in continuous operation throughout the year. The new steel furnace is also complete and was gassed early in December preparatory to beginning melting. By the end of the year work on some new gas producers and on a furnace charging machine had progressed to a stage at which it was possible to say that they would be in operation "early in 1951." The construction of the additional soaking pits had reached a similar stage by the end of the year, one of them being just about ready for operating.

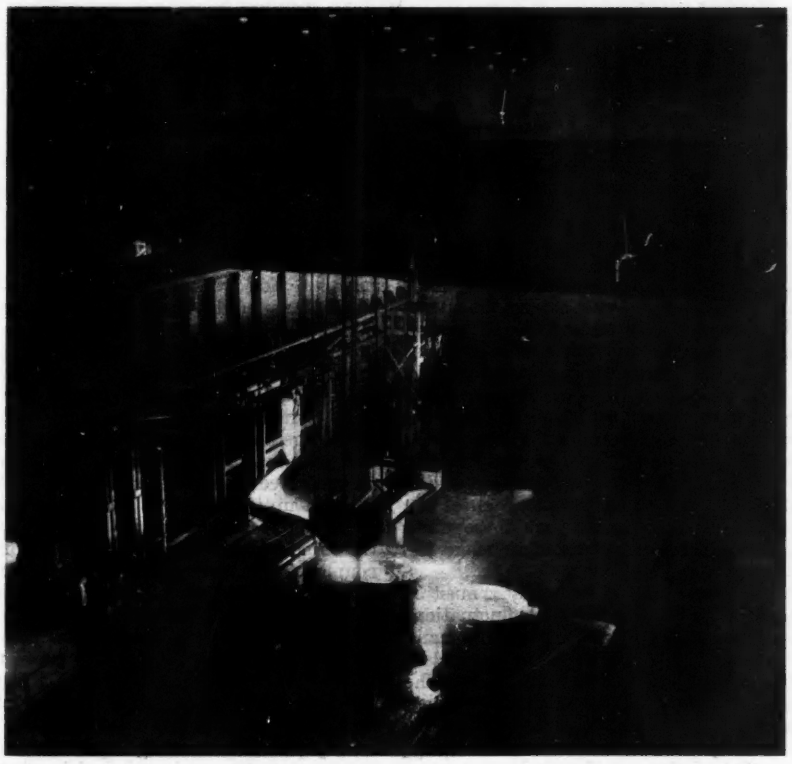
The portion of the steel industry's development plan which deals with Scotland includes reconstruction and extension at the Clyde Iron Works and the Clydebridge Steel Works of Colvilles, Ltd. At the former, new coke ovens and a new blast-furnace have been built, and in July, 1950, the new blast-furnace gas cleaning plant, which has a capacity of 6,250,000 cubic feet of gas per hour, was put into commission. This plant, shown in one of the engravings, consists of two precoolers, 22ft in diameter by 63ft effective height, which are supported on independent welded steel structures at sufficient height to enable the effluent to flow by gravity to the treatment plant. Each precooler is fitted with a set of water spray rings, the crude gas entering at the bottom and leaving at the top, where it passes into the semi-clean main, from which point distribution takes place to two of three wet gas disintegrators, which are each capable of handling 3,250,000 cubic feet of gas per hour. They are driven by 850 h.p. motors running at 750 r.p.m., and the three machines complete with all electrical gear and instruments are housed in a building, with annexe, 110ft long by 20ft wide, which is 40ft above ground level. To remove the spray carried over from the disintegrators three spray separators are provided; they are cylindrical vessels fitted with Raschig rings. From the spray separators the clean gas is passed into an 8ft diameter clean gas main, which ultimately increases to 10ft to allow for future developments, and then ties into the existing clean gas main, where the gas passes to the standby, with a capacity of 2500 gallons per minute, have been installed for this supply.



BLAST FURNACE GAS CLEANING PLANT—COLVILLES

various consuming points. It is stated that the total water required for the precoolers and wet washers is 4200 gallons per minute, and three pumps, two running and one

At the Clydebridge Steel Works of Colvilles, Ltd., which are adjacent to the Clyde Iron Works, the No. 2 melting shop has been reconstructed and two 350-ton tilting furnaces have been installed. The provision of these furnaces, taken in conjunction with the existing 300-ton furnace and the 600-ton mixer, constitutes a major step towards the ultimate conversion of the shop from high scrap to high iron percentage melting. In order to house and service the new furnaces it has been necessary to extend the furnace bay, marshalling bay and casting bay by 320ft. The furnaces themselves are generally similar to the existing 300-ton unit, although some modification to detail has been made where experience showed it to be advantageous. Waste heat boilers with an expected output of 12,000 lb to 15,000 lb of steam per hour each have been fitted and a completely new furnace cooling water plant, including a 740,000 gallons per hour concrete chimney type cooler, has also been installed. The increased production required the provision of additional soaking pits, and since the existing soaker bay was unsuitable for expansion, four new soakers and two dead or unfired soakers have been arranged in line along one side of a new bay lying immediately adjacent and parallel to the extended casting bay. Moreover, the company realised that many difficulties might be met in the continued use of the old static method of ingot teeming, and consequently casting on cars has now been introduced. After teeming, the loaded cars are shunted into the soaker bay to be stripped and charged into the soakers. When reheated, the ingots are lifted by one of the two 25-ton overhead combined stripping and charging machines and placed in a travelling side-tipping ingot chariot, which discharges on to the slabbing mill approach table.



NEW MELTING SHOP—ROUND OAK STEEL WORKS

An interesting development in the Midlands is the modernisation and extension scheme at Round Oak Steel Works, Ltd., Brierley Hill, Staffs. The works are situated in a steel-making area which has no local ore, but which takes large quantities of scrap from the surrounding neighbourhood. Prior to the steel industry's development plan the Round Oak plant consisted of two blast-furnaces, each making cold blast pig iron; two melting furnace shops, together with a cogging mill, heavy section and billet mills, and three re-rolling mills. The modernisation scheme provides for a new melting furnace plant comprising five 100-ton Venturi open-hearth furnaces, each fitted with a waste-heat boiler, and an extension of the existing scrap bays. The installation of the plant will mean an increase in the annual ingot output from 160,000 tons to

300,000 tons. Other items in the scheme are the installation of a new electrically driven 37in cogging mill, the electrification of the existing 28in and billet mills, and the installation of a cross-country mill.

The melting shop building, which is 786ft long by 108ft high, has a combined furnace and casting bay span of 150ft. The open-hearth furnaces are equipped with water-cooled skewbacks, door jambs and lintels, and water-cooled blocks, and are designed for cold metal charging. The charging boxes, each having a capacity of 34 cubic feet, are deposited at the back of the furnace charging platform, and are picked up by a swivelling charging machine. Steam produced from the waste-heat boilers with which the furnaces are fitted is expected to be almost sufficient for the subsequent steel-works operations. The main scrap bay runs the full length of the melting furnace building, with a span of 120ft, and the scrap, when loaded into boxes, is lifted on to the platform by a box handling device fitted to each of four magnet cranes. The ingots produced at Round Oak weigh 3¾ tons and are cast on ingot bogies which are then conveyed to the stripping bay adjacent to the soaking pits and mills. Four existing soaking pits are being retained, and three one-way-fired pits have now been installed, giving an additional heating capacity of 2200 tons of ingots a week for rolling down purposes. During last year, the new melting furnace plant was put into operation. A view of part of the plant is reproduced in an accompanying engraving.

Installation of the electrically driven 37in cogging mill is nearing completion. The cogging rolls are 8ft long and the mill is fitted with side guard manipulators with tilting fingers on both sides. Roll changing is effected by a skid roll changing rig, and scale from under the rolls is cleared to a settling pit by water flush, the scale at the pit being removed by a grab crane direct into railway wagons. The bloom shears are steam hydraulic of the up-cut type, and the run-out table gear is arranged so that hot blooms can be sent direct to the 28in mill reheating furnace or to the hot banks for dispatch to the cross-country mills. The cogging mill will roll down the 3¾-ton ingots to 4in blooms when required, the majority of blooms being about 70 square inches in cross-sectional area.

Conclusion

Those items in the steel development programme which have been described in this review represent only a part of the reconstruction work which has been continued by the British iron and steel industry during the past year. There are many other schemes which have made good progress. One example, of course, is the largest of all the projects incorporated in the development plan—that of the Steel Company of Wales, Ltd., at Margam and at Trostre, near Llanelly. Work completed last year at Margam included the new No. 2 blast-furnace which was blown in on November 7th. This furnace, designed and built by Ashmore, Benson, Pease and Co., Ltd., has a hearth diameter of 25ft 9in, and is rated to produce 1000 tons of basic iron a day. It is one of a group which will supply hot metal to the company's new steel plant at the Abbey works. Then, there are various schemes which the United Steel Companies, Ltd., has in hand. This group includes the Appleby-Frodingham Steel Company, at whose works at Scunthorpe, there is a project for extending the ore-preparation facilities. Early in November, a new two-strand Dwight Lloyd sinter plant began to operate, each strand having a capacity of 1000 tons of air-cooled sinter per day. After reconditioning the two old strands, the total daily capacity for the plant will be nearly 4000 tons. This is the first stage of the ore-preparation development programme which, it is expected, will be completed by the summer of this year.

Finally, the British Iron and Steel Federation has announced this week the production figures for 1950. They show that the output of steel ingots and castings totalled 16,292,700 tons and thus exceeded the upper limit of 16,000,000 tons forecast in the *Economic Survey*. It is noteworthy that 1950 was the fourth year in succession in which the Government's target for steel output has been surpassed. Pig iron production in 1950 totalled 9,632,900 tons, compared with 9,498,500 tons in 1949. It should be added that during December—when account must be taken of the Christmas holiday—steel production was at an annual rate of 15,408,000 tons. This was the highest rate ever achieved in December.

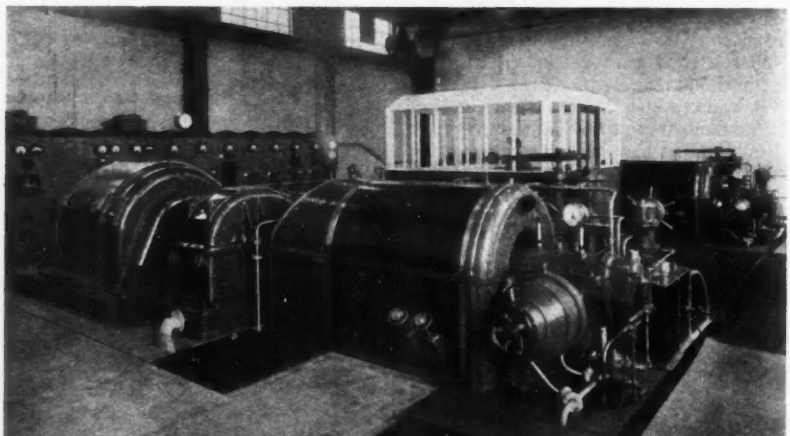
Electrical Engineering in 1950

No. II—(*Continued from page 26, January 5th*)

ALTHOUGH the bulk of this country's electricity requirements are met by the public supply system, there are many instances where a private supply is economically justified either to serve as a standby or where process steam is involved.

An interesting example of the latter is provided by plant which has been designed to operate in conjunction with a water-gas producer at Beckton Gas Works. This installation (described in our issue of November 10, 1950, page 433) generates gas in the usual manner by blowing air and then steam through a hot coke bed. During the air blow which forms the first part of the production cycle the waste heat that is generated is used to raise steam in waste-heat boilers at 290 lb per square inch gauge. This steam drives a pass-out turbo-alternator which provides low-pressure steam at 15 lb per square inch gauge; since the amount of high-pressure steam generated exceeds the process steam requirements the installation includes a condenser. The cycle of operations involves an air blow of one minute and a steam run of two minutes with each of the four gas producing units, but these units will be staggered in operation to make the loading cycle more uniform.

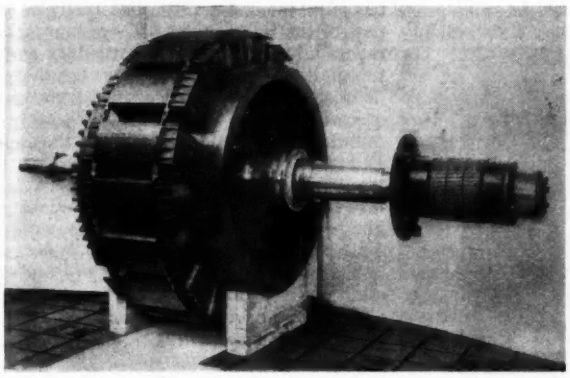
For this duty the turbo-alternator must be designed to tolerate considerable fluctuations in steam supply and variations in the demand for process steam; the set must also be robust and reliable in operation, with the minimum of skilled attention. These considerations led the electrical consultants for the scheme, Messrs. Mackness and Shipley, to recommend the use of an induction generator. The usual objection to an induction machine—its effect on the power factor—is invalid in this instance because the total electrical load in the works is large enough to ensure that the overall power factor will not be lowered appreciably. The turbo-alternator set was built by W. H. Allen, Sons and Co., Ltd., Bedford, in conjunction with Humphreys and Glasgow, Ltd., and Lancashire Dynamo and Crypto, Ltd. The generator itself is of conventional squirrel-cage construction, the stator being connected to the supply mains to provide the necessary excitation. It is a totally enclosed machine, with a continuous maximum rating of 1390kW, 0·93 power factor loading, generating at 6·6kV when driven through gearing at 1514 r.p.m. by the turbine, running at 6000 r.p.m.



Turbine Room, Kingsbury Colliery Power Station

The arrangements for starting and paralleling the induction generator are interesting. At full load the alternator runs at 1 per cent above synchronous speed. To obviate shocks to the gears and flexible coupling, and to avoid the unstable ranges of the generator's torque/speed characteristics, the set is brought up to 1 per cent above synchronous speed before switching in. Measurement of the speed is done by an electrical tachometer coupled to the generator shaft—the turbine tachometer being considered unsatisfactory because of its inability to take account of mains variations. The tachometer indicator has a separate frequency meter element which is energised from the station busbars and carries two pointers—a main pointer indicating busbar frequency and a subsidiary pointer indicating 1 per cent higher. In operation the set is switched in when the tachometer generator pointer lies between

the two busbar frequency pointers. Transient magnetising currents of the order of twelve times the full-load current would flow if the generator were switched directly on to the busbars. To limit the transient to about three times full-load current and thereby reduce the disturbance on the external supply network, a reactor is connected between the generator and busbars at the instant of switching. When the generator is excited the reactor is short circuited, leaving the machine connected directly to the busbars.



FLYWHEEL ROTOR OF 1495kW ALTERNATOR FOR BAHAMAS

Kingsbury Colliery Power Station

Electric power requirements for surface use and underground working at the Kingsbury Colliery (Warwickshire Area, West Midland Division, National Coal Board) have higherto been met by taking a supply from public mains, but a recent power plant installation has made the colliery independent of external electricity supplies.

The supply of low-grade coal used for raising steam for winding in the Dexter and Ryder shafts having recently increased it was decided to extend the existing boiler plant and install turbo-alternators. The turbines now running use exhaust steam from the winding engines and a direct supply from the boilers in a mixed pressure arrangement.

The power station is connected to the B.E.A. 3·3kV network at a surface substation at the Dexter shaft. The switchgear is so arranged that the alternators can be paralleled with the B.E.A. supply or run independently as required. Alternatively, the substation at the Dexter shaft can be fed from the B.E.A. network and that at the Ryder shaft from the local supply.

Our illustration on page 64 shows the newly commissioned plant, comprising two mixed-pressure turbo-alternators, each rated at 1250kW. The turbines run at 6000 r.p.m. and are coupled through double helical reduction gears to salient-pole alternators running at 1500 r.p.m. The steam supply at the turbine stop valve is at 175 lb per square inch, 500 deg. Fah. total temperature, and the low-pressure supply from the winder exhaust is at 16 lb per square inch absolute.

Approximately 15,750 lb per hour of low-pressure steam are available from the winding engines during the colliery working shift, the high-pressure steam being taken direct from the boilers. The proportions of high and low-pressure steam admitted to the turbine are controlled automatically by means of the mixed-pressure gear, which ensures that only the minimum quantity of high-pressure steam is used to supplement the low-pressure supply to the turbine at any particular loading. Each turbo-alternator is equipped with an oil purifier and a separate gauge board, complete with a kilowatt-hour meter, mounted in an easily accessible position at the turbine end of the set.

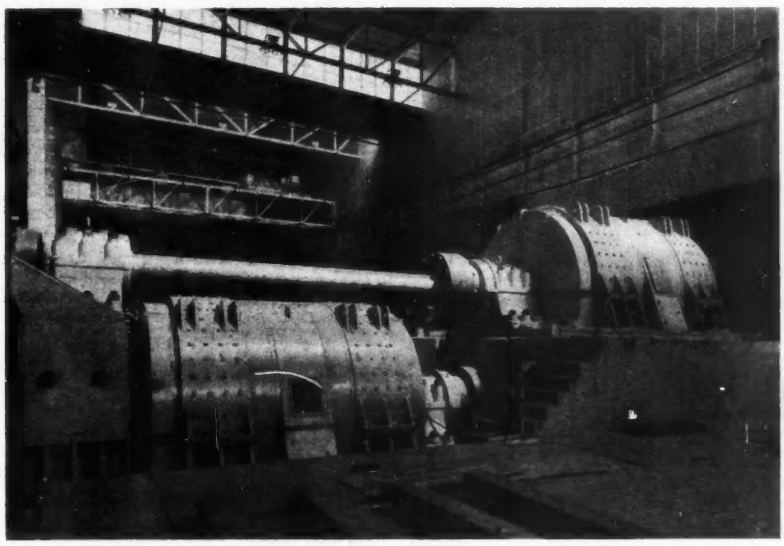
In the background of our illustration is the main turbine room switchboard; it is a truck cubicle installation, consisting of twelve panels, and is equipped with manually operated oil circuit breakers of 25MVA breaking capacity. Brown Boveri automatic voltage regulators, which control the output voltage of the alternators to plus/minus 0·75 per cent from no-load to full load, are mounted on the switchboard; earth leakage protection for both alternators is provided.

The electrical demands of Kingsbury Colliery at the present time can be met by a single turbo-alternator, the second set being used as a standby. A 3·3kV overhead feeder to Birch Coppice Colliery is now in hand, and when this line is complete both alternators will be needed to meet the additional load.

The contracts for the generating plant, switchgear and auxiliaries were placed, prior to vesting date, with the General Electric Company, Ltd., by Kingsbury Collieries, Ltd., the scheme being handled by H. W. Hollands, B.Sc., A.M.I.Mech.E., M.I.F., who acted as consultant.

One of the illustrations on this page shows the rotor of a diesel engine driven alternator manufactured by Lancashire Dynamo and Crypto, Ltd., for export to the Bahamas. An interesting point about this machine is that the rotor embodies sufficient moment of inertia to ensure the required degree of uniformity in angular velocity, without a separate flywheel. The flywheel effect is achieved by extending the cast steel yoke of the revolving field as shown in the illustration. For barring purposes teeth are incorporated in the casting, at the driving end. A continuous damper winding is provided in the pole faces, as shown, to make the alternator suitable for operating in parallel with six other large alternators supplied by the same company.

A turbo-alternator of unusual design is being made by the British Thomson-Houston Company, Ltd., for the Ford Motor Company, Ltd., at Dagenham, where it will be installed in the company's power-house to supplement the existing generating capacity. It is designed for operation at initial steam conditions of 195 lb per square inch gauge, 550 deg. Fah. total temperature with steam taken either from the extraction steam system, or the existing low-pressure boilers, and has a continuous maximum rating of 15MW. The machine will operate under these conditions on weekdays when the factory load is high and the existing 30MW sets are running; but at week-ends, when the demand is lower, it is intended to shut down the large units and supply the new machine with steam at a pressure of 375 lb per square inch gauge, 840 deg. Fah. total temperature, taken from the 1200 lb per square inch gauge high-pressure boilers through a reducing and desuperheating system. Under the higher initial steam conditions at week-ends the set will be capable of a continuous output of 17·5MW. Generation will be at 11kV, three-phase, 50 c/s, feeding on to the existing system with a normal air-cooled alternator and direct-coupled exciter group. The turbine will exhaust into a condenser suitable for cooling water at a temperature of 750 deg. Fah. In addition, steam will be bled from the turbine for feed-heating purposes; an interesting point about the feed-heating system is that a live steam heater, using initial pressure steam, will be used to raise the temperature of the feed water to a level suitable for introduction into the high-pressure boiler system.



45IN SLABBING MILL MOTORS AT ABBEY WORKS

A Slabbing Mill Drive

While general progress in steel works is dealt with in another article in this issue, some details of a particular electrical installation completed by the English Electric Company, Ltd., during 1950, may be of interest. The equipment comprises a hot mill reversing drive for a 45in slabbing mill at the Abbey Works of the Steel Company of Wales. It is stated to be the first twin drive in the British steel industry and the largest reversing drive in Britain, with a peak rating of 27,600 h.p., a speed of 40/80 r.p.m., and a

maximum torque of 3,600,000 lb-ft. Rapid-acting control exciters are employed and the control system gives quick response, with voltage and current limiting and automatic compounding on excess loads. Controls for holding torque and speed ratio are included and the feed rolls of the mill are driven by steelworks motors under the control of a system similar to that on the main drive.

The slabbing mill is the first stage in the production of strip steel from the ingots,

2000H.P. MOTOR GENERATOR SET ON TEST

and is driven by two motors, illustrated herewith, one motor being connected directly, but through universal spindles, to each of the two 45in diameter rolls of the mill. There is no mill pinion housing, and there is thus no mechanical connection between the two motors except through the slab being rolled. This arrangement forms the well-known "twin" drive now being used on many large drives. The two motors together are capable of exerting a peak torque of 3,600,000 lb-ft, which makes the equipment equal to or larger than most of the recent American drives for comparable duty. This torque is available at speeds up to 40 r.p.m.; at higher speeds, up to the limit of 80 r.p.m., torque falls off to keep the peak rating at 27,600 h.p. Each of the two motors has two armatures, to assist in keeping a satisfactory distance between top and bottom motor shaft centres; this construction also helps to reduce inertia and so speeds up the reversing of such a large machine. The complete twin motor is fed from a flywheel (Ilgner) set having four generators, an induction motor and the necessary load-equalising flywheel. Each generator is rated at 1850kW, 550V, and the circuit is such that the voltage to earth cannot exceed twice this figure; the Ilgner motor has a rating of 6500 h.p. and drives the set at a synchronous speed of 500 r.p.m.; the stored energy capacity of the plate-type flywheel is 200,000 horsepower-seconds, sufficient to cover all calculated mill demands with a fall in speed of not more than 20 per cent.

Both mill motors and their generators are controlled from a foot-operated master controller in the operating pulpit, seven speeds being obtainable between standstill and 40 r.p.m., and a further six speeds between 40 and 80 r.p.m. The controller acts in the field circuits of two special rapid-response control exciters which, in turn, control two main exciters connected in motor and generator field circuits. The scheme adopted, although relatively new, is already in operation on other equipments, and is specially designed to give rapid change of motor speed and reversal in conjunction with other desirable characteristics, including generator voltage control, current-limit control, and forced compounding of the mill motors in the event of excessive loads being imposed on them. Additional machines form a separate control system for dealing with unbalance in the load currents of the upper and lower motors, and the circuits will hold the torque differential between the two motors at preset values up to plus or minus 25 per cent. Differential speed control is also provided and is adjustable for different roll diameters. The Ilgner set draws on the 11kV system for its power and on the mill general-purposes 110V exciter for dynamic braking excitation. The main exciter set is fed from the 3·3kV system, and the auxiliary exciter set from the 415V system.

An extensive lubricating system has been included, for supplying all main bearings. Pressure lubrication is fitted on the mill motor bearings, on the extra bearing for carrying the outer end of the extended spindle over the lower motor, and on the flywheel bearings which also have mechanically driven pumps for safety reasons. Gravity lubrication is used for the remaining bearings on the Ilgner set, simply to ensure all heat being adequately removed. Full protection is included by flow relays and pressure relays where required.

All the main machines are forced-ventilated, on two recirculating systems, one for the motors and one for the Ilgner set. Air/water coolers are included. An unusual provision is that a small portion of the air passing through each d.c. machine—that is, the air that passes over the commutator and collects brush dust—is removed from the system by axial-flow extraction fans in the ducting, and is made up by a corresponding amount of air sucked through electrostatic precipitation filters, of which there is one for each air circuit.

Because of the inherent working of the control exciter system, there are very few relays or contactors in the equipment; the complete contactor board is thus only about 7ft long, and there are only two relays which have to work frequently. The control equipment therefore really comprises only the contactor board, master controller, torque and speed differential rheostat cubicle, and series transformer for the Ilgner set.

Associated with the main mill drive are the drives of the two rollers on each side of, and next to, the main rolls, but really forming part of the roller tables. These four "feed" rollers have an unusually hard duty and the proximity to the mill complicates the drive details. Each pair of rollers is driven through a gearbox from a heavy-duty steelworks motor. These two motors are of the English Electric "C.M.R." class and are fed from two variable-voltage generators having a rapid response voltage control and current-limit control system with exciters, as for the main drive. The "feed" roll systems are operated from the main contacts and from additional contacts in the master controller already referred to, so that approximate speed synchronisation with the mill is automatically achieved.

A good example of a modern geared electric winder drive is the equipment illustrated on this page. The photograph shows the motor generator set undergoing works tests by the Metropolitan-Vickers Electrical Company, Ltd., prior to being shipped to Australia for the New Broken Hill Consolidated, Ltd. The motor generator set consists of two 1000kW, 360V d.c. generators (connected in series to give 720V at 800/860 r.p.m.), driven through a Vulcan Sinclair hydraulic coupling by a 2000 h.p., 6·6/7·2kV, 800 r.p.m. synchronous induction motor. Incorporated with the motor generator set is a flywheel—the largest so far manufactured in the company's Trafford Park works—which is 11ft 3in in diameter, weighs 58 tons, and has an energy storage capacity of 401,000 horsepower-seconds. The flywheel is of the company's normal unpierced construction, with bolted-on stub shafts, and is made in three separate pieces for ease of manufacture.

(To be continued)

Pollution Prevention in Canada

MEASURES to facilitate control and prevention of pollution in the boundary waters connecting Lakes Superior, Huron, Erie and Ontario have been recommended to the governments of Canada and the United States in a report by the International Joint Commission. The recommendations, submitted by the Commission, after studies which began in 1946 at the request of the two Governments, contain the following provisions:—First, the adoption by the two Governments of specific objectives for boundary waters quality control, as the criteria to carry out that portion of the boundary waters treaty of 1909, by which the two countries agreed that boundary crossing waters "should not be polluted by either side to the injury of health or property on the other." Secondly, the accomplishment "by those responsible for pollution" of the measures necessary to obtain or maintain the specific water quality objectives, a programme which the Commission said would "necessarily require many years for completion and would cost approximately 125,000,000 dollars. Thirdly, the continuing supervision of boundary waters quality control by the Commission through international boards of control and through the appropriate authorities in each country charged with enforcement of pollution control laws.

Aeronautics in 1950

No. II—(*Continued from page 9, January 5th*)

THE experience gained with gas turbine-propelled aircraft during the year can leave little further doubt as to the permanence of this form of propulsion for civil aircraft or its readiness for immediate introduction to the world's air routes. Such great and rapid progress is noteworthy in view of the diverse problems, both technical and operational, which arose quite apart from those directly associated with the turbine itself. This British achievement is even more creditable when it is realised that these complications did not creep in singly but were mostly evident from the start. They acted, however, as a spur rather than a deterrent, whereas the Americans, amongst others, seem to have thought that the attainment of commercial flight was impracticable for some years to come.

One quite serious problem incurred by flight at the optimum operating heights around 35,000ft, is the marked changes which are exhibited in the physical and mechanical properties of aircraft materials when exposed to sub-zero temperatures as low as —90 deg. Cent. found at that height. These changes affect all the major characteristics except Poisson's Ratio in certain metals, and uniaxial tests on a mild steel specimen show an increase in Young's Modulus in the region of 6000 lb per square inch per deg. Cent. below room temperature, and considerable increases in the yield and ultimate stresses. However, when the stress distribution is of a triaxial nature, e.g., when an Izod notch is cut into one side of the tension specimen, the test piece may exhibit extremely brittle characteristics and the rupture stress may drop from 28 tons per square inch at room temperature to 4 tons per square inch at —40 deg. Cent. Briefly, these characteristics are shown to a lesser degree to occur below the particular transition temperature in most carbon steels without a nickel content and in certain non-ferrous alloys, particularly the magnesium, the lead-tin, and the zinc alloys. Metals which are not affected appear to have a transition temperature below those experienced at high altitude. One explanation of this phenomena occurring with static triaxial stress—as distinct from dynamic (Izod) tests—is that modification of the intercrystalline boundaries at low temperatures prevents or restricts the degree of plastic flow and causes failure to occur by transcrystalline fracture. It is thus evident that the mechanical properties should only be determined when under the actual loading conditions in flight. Rubber also becomes brittle at low temperatures, and the low humidity associated with these temperatures has led to a considerable and somewhat unaccountable reduction in the life of commutators and brushes. Internal stresses in perspex also give rise to cracking when similarly exposed if contaminated with certain chemicals. It was also suspected that fuel tanks would need to be both pressurised, to prevent excessive losses due to vaporisation, and heated, to maintain a satisfactory viscosity value, when flying at these altitudes. One complication which was exceptional in that it was not anticipated was the discovery of air turbulence around the tropopause, which gave rise to gusts in clear air of such severity as to necessitate a revision of structural safety factors. The latest evidence available upon this matter suggests that the turbulence is related to the existence of pockets of air about 300 miles long and up to 3000ft thick, which move relative to the adjacent strata at speeds up to 100 m.p.h. Within them and possibly elsewhere, it is suspected that there exist horizontal temperature gradients and that as a consequence of these, vertical and nearly vertical wind velocities are generated upwards and downwards. An aircraft may therefore be subjected to upward and downward accelerations and it appears that at aircraft speeds this alternation may occur in phase with the natural periodicity of the wings. The turbulence commonly occurs at about 30,000ft, and as there is no visual indication of its presence, its occurrence is as yet unpredictable. There is no evidence to support suggestions that it is in any way dependent on the earth's contours. Research continued in 1950 towards the development of mechanical equipment which would be able instantly to detect the presence of a gust and to manœuvre the machine automatically to compensate for its effects. Investigations of this particular problem were first started in 1948, using de Havilland "Mosquito" aircraft and further contributions of a qualitative nature were derived from flight experience with the "Comet" prototype.

It was with the object of making more thorough and quantitative investigations into the various problems of high altitude flight that the Ministry of Supply ordered six Avro "Ashton" aircraft (THE ENGINEER, Sept. 22nd, 1950), fitted with suitable research equipment and pressurised and conditioned to fly at 40,000ft for long periods.

An intensive programme of test flying was continued throughout the year with the prototype "Comet" and with the first production model, which made its first flight in September. These two machines have now completed over 500 hours flying. Development flying with the latest "Comet," which now has internally balanced control surfaces, was concerned with the thermal de-icing equipment, suppressed radio aerials and distance measuring equipment. The de Havilland "Comet" has a payload of 12,000 lb for a range of 3500 miles, when cruising at 490 m.p.h. and at a height of 40,000ft. Under these conditions the cost per ton-mile of payload is claimed to be 20 per cent cheaper than that obtained by present aircraft. The introduction of the fourteen "Comets" into public service with B.O.A.C. is expected to commence early in 1952. The third aircraft of this consignment is expected to fly shortly and will be fitted with an eight-wheel bogie undercarriage. A further model of the "Comet," it is stated, is to be powered by an axial-flow turbine and will fly on the very long distance routes. Such an announcement from a firm manufacturing centrifugal flow gas turbines contains a marked admission of the fuel consumption advantages of the present axial over the centrifugal compressor. The type of jet-turbine to be fitted will probably develop about 7000 lb s.t. and the "Comet" when fitted with four of these might also serve in several military categories with distinction.

The other pure jet-turbine propelled airliner to have undergone extensive development trials satisfactorily was the Avro Canada "Jet Liner," which first flew at Toronto in August, 1949. Early performance claims of this aircraft state that over a block distance of 500 miles, although the operational cost per ton-mile of a typical conventional machine is 10 per cent lower because of the lower fuel consumption, the "Jet Liner" would show a profit 65 per cent greater because of its higher speed. Four Rolls-Royce "Derwent" turbo-jet engines are fitted of 3,600 lb s.t., and the cruising speed at an all-up weight of 60,000 lb at 30,000ft is 450 m.p.h. The "Jet Liner" accommodates forty to sixty passengers and has a maximum economic payload of 12,700 lb. The fuel capacity is 3400 gallons and the cruising consumption about 800 gallons per hour. The latest pressurisation, refrigeration and humidification equipment has been installed and the aircraft is able to maintain sea-level conditions up to 21,000ft with 4000ft conditions at 30,000ft. The maintenance of such high cabin-air pressures enables this machine to descend at very great rates, whereas aircraft which normally maintain 8000ft conditions when flying at 25,000ft are obliged to descend at rates no greater than 300ft per minute to avoid passenger discomfort, involving a descent of up to 45 minutes' duration. To withstand these pressure requirements it was necessary to test the fuselage of the "Jet Liner" with a differential pressure of 16 lb per square inch. In this connection Canadian aviation medical authorities have revealed that the only physiological effect of sudden decompression from, say, 12 lb to 4 lb per square inch, in the event of a window blow-out at 40,000ft would be the inability to breathe even though the cabin were filled with pure oxygen: but if the aircraft were dived to 30,000ft the average person could breathe, assuming there to be a sufficient supply of pure oxygen.

Most aerodynamic details of the "Jet Liner" are now available. The wing is a high cambered aerofoil with a thickness-chord ratio of 16 per cent at the root and 12 per cent at the tip. The critical Mach No. of the aerofoil is slightly higher than 0·7 and therefore is greater than the optimum cruising speed so that the need to use sweepback was avoided. As a consequence, the landing characteristics are noteworthy and when landing at the maximum landing weight of 40,000 lb the stall is as low as 78 m.p.h., using split flaps. When the Handley Page double-slotted flaps are fitted the stalling speed might be as low as 72 m.p.h.—an excellent achievement for aircraft of this weight, designed to cruise at 450 m.p.h. The wing has an area of 1157 square feet, a span of 98ft and an aspect ratio of 8·3 : 1. An interesting wing to fuselage fillet effected a 7 m.p.h. reduction of the stalling speed by eliminating the upflow from the long fuselage nose occurring at the wing root. Design of the engine installations led to the adoption of single underslung nacelles. This arrangement avoids interference with the main wing spars, an important structural consideration should the future power requirements change. The pressure recovery characteristics of the plenum chambers would not have permitted, with the "Derwent" engines, a combined elliptical nacelle and air intake, as is employed on the Avro "Ashton" fitted with Rolls-Royce "Nene" engines, as the diffusing angle would have been greater than 10 deg., causing breakaway. Water-Methanol is used for thrust augmentation at take off.

PROPELLER-TURBINE AIRLINERS

The use of prop.-turbine propulsion has proved of more immediate value for civil transport, for, not flying as high nor as fast as the pure jet aircraft, they have proved

easily adaptable to existing air traffic control requirements. The fuel consumption of prop.-turbine-propelled aircraft although higher than piston-engined machines, is far less critical to height and speed conditions than are the pure jet-propelled aircraft.

The Vickers "Viscount 700," fitted with four Rolls-Royce "Dart" propeller-turbines, has now completed eighty scheduled flights on routes from Northolt to Paris and Edinburgh. The "Viscount" carries forty passengers when seated without bulkheads and cruises at 316 m.p.h. when flying at 25,000ft with an all-up weight of 50,000 lb. The cabin pressure differential at this height is 6·5 lb per square inch. The fuel capacity is 1620 gallons when not carrying methanol and the cruising consumption is 220 gallons per hour, which can be reduced to 200 gallons per hour when flying on two engines at 240 m.p.h. B.E.A. now await the delivery of the production version of this machine, of which twenty-eight have been ordered. Operating costs already available show that the cost per aircraft mile is lower than that of conventional aircraft in the same category; its payload for ranges up to 600 miles is 12,000 lb.

In a similar category to the "Viscount" is the Armstrong-Whitworth "Apollo," fitted with four Armstrong-Siddeley "Mamba" propeller-turbines, which develop 1500 e.s.h.p each. It has just received a Certificate of Airworthiness limited to non fare-paying passengers. This machine has completed over 200 hours' flying and is shortly to start proving and tropicalisation trials. Designed to carry twenty-four to thirty-one passengers on short and medium range routes, the "Apollo" has an all-up weight of 45,000 lb.

The "Hermes V" aircraft made by Handley Page Company, Ltd., and fitted with four Bristol "Theseus" propeller-turbine engines, is claimed to be the largest and fastest aircraft of its kind. The payload is 17,000 lb for distances up to 2000 miles and the maximum range is 3500 miles. At 25,000ft and an all-up weight of 90,000 lb, the cruising speed is 340 m.p.h. This company has carried out extensive flight experiments in the development of high-lift landing devices with "Hermes" Mark IV and V aircraft and both these aircraft are now fitted with double-slotted flaps. It will be recalled that this firm has long been associated with research in this field. When compared with the single-slotted flap the new system reduces by 6 per cent the take-off distance before attaining 50ft, with a corresponding reduction in stalling speed of 4 m.p.h., or for a given take-off distance the all-up weight may be increased by 2000 lb. The landing run, when similarly compared, is reduced by 10 per cent and the stalling speed by 6 m.p.h. These improved take-off and landing figures are achieved with a smaller flap, of 9 per cent wing chord, set into and working in conjunction with a main flap of 15 per cent wing chord. When the flap is lowered, the inset moves rearwards and down. In the neutral position the smaller flap sits inside the larger and gives a wing-chord no greater than that of the ordinary slotted flap. The increase in chord for take-off is 7 per cent for the new double-slotted flap in comparison with 2½ per cent for the single-slotted. For landing, the increase is 12½ per cent, against 4 per cent.

The Handley Page Company has also considered the use of forced boundary layer control to increase the maximum lift coefficients for landing and take-off. This method consists of a rocket-operated feed pump, so that steam is generated inside a wing chamber and ejected at high velocities through ducts so as to accelerate the air flow along the wing contour. This system was first used on a German aircraft, the "Arado 232," and has proved to be a far more effective method than using the propellant directly as a pure thrust agent. This latter method merely reduces the take-off run and cannot be used when landing. Whereas when the propellant is used to stabilise the boundary layer a considerable reduction is made to the minimum flying speeds throughout the required period.

Some comparative performance figures of the "Hermes" aircraft are available. The "Hermes," when fitted with four "Hercules" piston engines of about 2000 h.p. each, cruises at 285 m.p.h. with an all-up weight of 84,000 lb. When powered by four "Theseus" prop-turbines developing about 2600 e.s.h.p. each the aircraft cruises at 355 m.p.h. with an all-up weight of 90,000 lb. Both have a range slightly over 3000 miles and carry the same payload of 17,000 lb for distances up to 2000 miles.

Good progress was maintained during 1950 towards the completion of the "Princess" 100-passenger, 140-ton flying-boat, which is expected to make its maiden flight by about September of this year. Three of these aircraft are under construction at the East Cowes works of Saunders-Roe, Ltd. Whilst there is yet considerable controversy with regard to the respective merits of flying-boats and land-planes, certain trends are becoming more clearly defined as the size of these aircraft increase. When scaling up the early machines to the present sizes of the "Brabazon" and the "Princess" the function by which the weight of the undercarriage and its auxiliary equipment increases with the overall weight is distinctly more adverse than the corresponding increases in the total weight of flying-boats, caused by the increased structural requirements of the hull. Furthermore, from drag considerations a similar trend exists, which shows that with the present dimensions of these aircraft there remains little disparity between hulls, now of considerably improved aerodynamic efficiency, and typical fuselages. The Saunders-Roe Company claim that the "Princess," with a weight/power ratio of only 9½ lb per h.p., will show at least a 3 per cent advantage over a land-plane with similar payload capacity and range. Flying-boats are thought also to be able to alight in emergency on the seas over which they will normally be routed. One such route would be that to Australia, which would be covered in two days with four stops. They have also a virtually unrestricted approach and landing-run, which should considerably facilitate "blind" landing techniques. Fitted on the high wing are ten Bristol "Proteus" propeller-turbines, eight of which are arranged in four coupled pairs, driving single contra-rotating and reversible propellers of 16ft 6in diameter. The "Princess" is designed to cruise at 380 m.p.h. over a still-air range of 5500 miles and at a height of 30,000ft, at which altitude it will maintain 4000ft conditions in the hull. The aircraft has a span of 220ft, length 148ft, height 55ft 9in, and a beam of 16ft. 8in

The Blackburn and General Aircraft Company has now conducted over thirty hours' test flying with the "Universal Freighter," which is one of the largest aircraft in this country. The all-up weight is 100,000 lb, of which 31,200 lb is disposable. The wing loading is 34·3 lb per square foot and when fitted with four "Hercules 761" reciprocating engines the power loading is 12·8 lb/h.p. The tricycle undercarriage is non-retractable; power-operated controls are fitted with Fairey hydro-booster units. This machine has a load capacity of 5760 cubic feet with a range of 2000 miles. It has shown excellent handling characteristics; the landing speed is 88 m.p.h., with a landing run of 225 yards, and the machine requires only 585 yards to take off.

The Bristol "Brabazon I" has been undergoing further normal flight development. The "Proteus" gas-turbine, which is to be fitted to the "Brabazon II," is undergoing tests in a mock-up wing and in the "Lincoln" "flying" test bed.

Two excellent feeder line aircraft were demonstrated during the year. The "Marathon I," built by Handley Page, Ltd., was designed to provide a modern medium-range passenger/freight transport. This high-wing all-metal machine is intended to carry up to twenty-two passengers, representing a payload of more than 4000 lb, at cruising speeds between 160 and 210 miles an hour for 500 miles. It has a wing span of some 65ft, giving a wing area of 498 square feet. The "Marathon" has that advantage of high wing aircraft whereby all passengers can see where they are going. The nearness of the cabin floor to the ground obviates the use of ground-loading equipment.

The "Marathon I" has four supercharged D.H. "Gipsy Queen" engines, each of which gives a take-off power of 345 b.h.p. With an all-up weight of 17,100 lb the machine has a maximum speed of 232·5 m.p.h. at 6750ft.

A direct development of this piston-engined machine is the company's "Marathon II," which, with two Armstrong-Siddeley "Mamba" propeller-turbine engines, cruises at 255 m.p.h. over a range of 908 miles with a payload of 6600 lb.

Another feeder line machine is the de Havilland "Heron," powered by four unsupercharged de Havilland "Gypsy Queen" engines. To reduce maintenance to a minimum the undercarriage is "fixed," there is no hydraulic system and the propellers are non-feathering. The range is 400 miles when satisfying all I.C.A.O. requirements, and the payload is 3360 lb or seventeen passengers. With a fuel consumption of only 4 m.p.g. the operating cost per ton/mile varies between twenty and thirty pence. The market price of the "Heron" is £35,000.

(To be continued)

A National Scrap Drive

The British Iron and Steel Federation, the Joint Iron Council and the National Federation of Scrap Iron, Steel and Metal Merchants last week sent a letter to 15,000 iron and steel users in the United Kingdom, emphasising the urgent need for ferrous scrap. The letter points out that iron and steel production in 1950 was again a record, but that such an achievement would not have been possible without adequate supplies of raw materials. Raw material supplies are, however, now becoming more difficult and high production depends on increased quantities of scrap being sent back to the furnaces. As the need for the maximum supply of scrap from home sources is vital, the letter urges iron and steel users once again to have a thorough search made in all works, shops, stores and yards, for every hundredweight of scrap for which they have no further use. In addition, it is stated, there is still a considerable quantity of scrap which can be secured by dismantling obsolete plant. Joint District Scrap Committees are functioning in all areas of the country and are ready at all times to assist in the scrap drive. The three associations responsible for this appeal are making a special approach on the matter to the services, public undertakings and municipal bodies, Government departments, and through the Federation of British Industries, to industry as a whole.

Labour in 1950

By GERTRUDE WILLIAMS

No. II—(*Continued from page 7, January 5th*)

Wages of Skilled and Unskilled

A SIMILAR difficulty in sorting out our ideas of wages is well illustrated in the confused movements that have taken place in wage structures in other industries during the year. Two incompatible tendencies have been at work. On the one hand social and compassionate reasons have induced us to try and concentrate rises in rates of pay in the lower grades of workers; on the other, the recognition of the desperate need for increased productivity at lower costs has compelled us to realise the importance of offering adequate incentives to men to fit themselves for skilled jobs. Unfortunately we cannot pursue both these objectives at the same time. There is a strong belief that wage increases should be permitted and even encouraged where earnings are insufficient to enable workers to maintain the basic standard of living that is socially acceptable; but you cannot raise the wages of such groups and also maintain general wage restraint without narrowing the differentials between unskilled and skilled earnings to such a degree that there is little reason for young people to be prepared to train for skilled work nor for their parents to be willing to prolong the period of their children's semi-independence.

It is always difficult to fix a figure as the amount which it is essential for a man to earn if he is to be able to look after his family on the minimum standard that the community is willing to tolerate. It depends on whether one lives in the town or the country or whether one has heavy transport charges to and from work and on the number of children that have to be kept. But some figure—despite these differences—we do tend to have in our minds when judging whether certain groups are particularly badly off or not and nowadays it is generally thought that it is pretty hard going to bring up a family on much less than £5 a week. Some such figure, anyway, seems to have been in people's minds in recent wage agreements. In a large number of industries regulated by Wage Councils the minimum is now fixed round about this sum: the Agricultural Wages Board raised the minimum male wage, last September, to £5 and the railway unions finally agreed to accept the offer of 3s. 6d. increase for the lowest paid workers (which brought their minimum to 96s., though, in fact, their earnings are much higher than this). The raising of low grade rates does not, of course, mean that no hardship exists. There is no such thing as a standard family in standard circumstances and there are, doubtless, many families suffering from privation. But the time has come for us to get much clearer on how far we are prepared to allow social considerations to influence wages. It is not only humane, but sound economics to insist that an industry should pay its workers enough to maintain the minimum standard of living that the community demands of its members; for somebody must support the persons involved, whether they do it themselves through their earnings or receive help through social agencies; and an industry which cannot keep its head above water, unless its workers are partially supported by communal funds, is enjoying a concealed subsidy for which there is not necessarily a justification. Individual hardship, however, is no justification for a rise in wages. During the last few years we have built up a remarkable system of social services, the purpose of which is to ensure that no member of the community suffers want, and in the recent Annual Report of the National Assistance Board, there is strong evidence that there is no longer any hesitation, through fear of incurring loss of social prestige or of receiving inhumane treatment, in applying for it.

To concentrate improvements of wages on the pay of the lower grade worker, on the plea that many of their families are ill-provided for at present rates, may show a strong and laudable social sense, but it is almost certainly very uneconomic. In every industry there are complaints of the extreme shortage of skilled, experienced workers and every team sent out to survey the techniques of American industry comes back with the same story—that British industry is falling behind in the efficiency race. But our present wage policy gives no incentive to men to increase their skill. Men who are already skilled in their crafts do not readily take lower grade work even if the pay is comparable to what they could earn in their own crafts. Pride in one's own skill and a sense of social status are usually enough to prevent that. But the supply of skilled workers for the future depends on the readiness of young people to devote some years to learning a job for less immediate pay than they could get at semi-skilled work, and the constant narrowing of wage differentials in skilled and process work makes such training a poor investment. Why give up so much now for so little apparent advantage to come? With the prospect now opening before us of having to devote an even larger proportion of our resources to the needs of rearmament the importance of ensuring an adequate supply of skilled and well-trained workers need hardly be emphasised; but, as things are, we are not very likely to get them.

Indices of Prices

Bewilderment and resentment at the rising cost of living have focused attention once again on the method used to gauge changes in prices and, recently, there was a good deal of ridicule, not unmixed with bitterness, when the Interim Index of Retail Prices indicated a fall of one point, due to an improvement in the permitted strength of beer, at a time when most people were feeling that life had become intolerably expensive. From many of the speeches made on the subject and from the comments in the Press, one might have inferred that a group of wicked statisticians had engineered this fall for some sinister purpose, and even the more moderate comments showed wholesale and profound ignorance of the meaning and use of the Index.

A price index is the method used to gauge changes in the value of money, but as the value of money is what it will buy and as money can be used to buy anything at all that is offered for sale—from a bit of the earth's surface to a packet of pins—it is impossible to do more than get an ***indication*** of changes in its value: a completely accurate measurement is beyond our powers. The prices of the hundreds of things we buy don't all alter at the same time and by the same amount, and, therefore, the value of our money to us depends on whether and by how much the prices of the things we happen to buy have altered; we are unaffected by movements in the prices of things we don't purchase. If, for example, the price of a Rolls-Royce goes up I remain sublimely untouched; but if bus fares rise, I realise that my income now is worth less to me than it was before and has to be stretched more tightly to cover my needs. If, then, we wish to measure changes in the cost of living, we have first to decide whose living, in order to find out what kinds of things he spends his money on—for though a schoolmaster and a dock labourer now earn about the same annual amount, their patterns of expenditure are widely different—and then discover how much of his income he normally spends on the different kinds of things he buys. The present Interim Index of Retail Prices is based on the results of a nation-wide inquiry made in 1937–38 into the budgets of the wage-earning population. It included only those who, at that time, were earning less than £250 a year (i.e., about 90 per cent of all occupied persons) but it covered all kinds of occupations and all localities. On the basis of that investigation it was found that the average family laid out its income in the following way: of every £100, £34·8 was spent on food, £8·8 on rent and rates, £9·7 on clothing, £6·5 on fuel and light, £7·1 on household and durable goods, £21·7 on drink and tobacco, £7·9 on service (transport, &c.) and £3·5 on miscellaneous goods. It must be emphasised that these figures do not represent the lay-out of every family's income because, in fact, families are not all the same size and we do not act in exactly the same way. A man who is a non-smoker and an abstainer would, obviously, spend nothing on drink and tobacco and would lay out his £21·7 on other things, more household equipment, perhaps. Similarly, an affectionate father with a young family, would probably cut down on these items—drink and tobacco—in order to spend more on his children's clothing. But the wage-earning population as a whole, bought these different categories of goods in the proportions indicated and if we want to measure changes in the cost of living to working people we have to take account of this fact. A rise in the price of food is more important than a rise in the price of clothing because so much bigger a slice of the income is spent on food than on clothing and the Price Index takes this into account in its calculation. What it tries to do is to measure how much it costs, at different times, to buy the same quantities of goods and in the same proportions as in the base year.

The results of the investigation made in 1937–38 did not become the basis of the Index until 1947, when the Advisory Committee set up to advise the Minister of Labour on the matter believed that things were sufficiently stable to make the new index practicable. The base date was June, 1947 and since then the Ministry of Labour has calculated, each month, how much it would cost to buy what could have been bought in June, 1947, for £100, assuming that incomes were spent on the same things, and in the same proportions as had been shown by the inquiry in 1937–38. Of course, our way of living has altered since then and altered profoundly. Earnings have risen greatly; there has been no unemployment for ten years; rents are controlled so that

they require a smaller proportion of most incomes; many essential foodstuffs are controlled and kept at low prices by subsidies, and with all this there is a much larger margin free for other types of purchases on which comparatively small amounts could be spent before the war. But what else could have been done? An inquiry into budgets is an immense undertaking and cannot be done without a great deal of preparation. It needs time and manpower and neither of these has been available. Now, however, the Minister of Labour has called together his Advisory Committee to discuss with them whether the time has arrived for a new inquiry to provide a picture of the post-war pattern of expenditure on which to base an index of prices which could be a more faithful mirror of changes in the cost of maintaining present-day standards of living. But even if we do have a new basis the inherent difficulty of every price index will remain—that we differ very much from one another in the relative importance we give to the many constituents of our standards of living and no index can do more than indicate changes in the costs of maintaining one particular lay-out of income. It cannot, at one and the same time, measure the changes in the cost of living to groups of people whose ways of living are markedly different from one another.

Settlement of Disputes

There is one other characteristic of the post-war scene which came in for a good deal of criticism last year—the machinery for settling industrial disputes. The number of days lost through strikes was not, in fact, very large, but there was a constant threat of trouble and the troubles that arose—e.g., the gas strike, the dispute in the printing trade and the stoppage in the docks—were peculiarly irritating in their effects.

Freedom to strike (or, conversely, to lock-out) has long been considered, in this country, to be an essential corollary to collective bargaining; and some of the most bitter fights in trade union history were waged to establish this right. At the same time, there has been general anxiety to avoid this way of coming to terms, because of the immense amount of suffering and loss it entails, and, in most well-organised industries, an agreed procedure has been established for the discussion of matters on which agreement has proved impossible to the original negotiators. Ever since the end of the last century the Government has tried to encourage this process by offering its services to provide a conciliator or an arbitrator to act as an impartial third party in a dispute. This Government assistance was successful enough to be the basis of a more ambitious system, which was brought into being after the first World War by the Industrial Courts Act, 1919. Part I of this Act set up the Industrial Court, a permanent and independent tribunal, which is not in any way subject to Government or Departmental control nor is it connected with the judicial system. It is composed of persons representing the interests of employers and employed, with an independent chairman, to act as a Standing Arbitration Council "to which differences of general principles and differences affecting whole industries or large sections of industries may be referred in cases where the parties have failed to come to an agreement through their ordinary procedure." The Court is based on the "voluntary" principle, that is, the Minister cannot refer a dispute to the Court unless both disputants agree and the decision, even then, is not legally binding, though, in fact, it is usual for the disputants to accept it. Part II of the Act embodies a different principle. It empowers the Minister to inquire into the cause and circumstances of a dispute whether reported to him or not and, if he decides to do so, to set up a Court of Inquiry for that purpose. The main purpose of the investigation is to provide the public and Parliament with accurate information and, though the Court may, if it wishes, suggest what it believes to be reasonable lines for a settlement, that is not its main function. It was under that part of the Industrial Courts Act that there was set up the recent Court of Inquiry into the printing dispute which issued, in October, its clear analysis of the causes of the dispute and its suggestions for a compromise. Another Court of Inquiry into the claims made by the three railway unions has just been brought into being.

Superimposed on this system is a provision of a different type—the National Arbitration Tribunal, which dates only from 1940. It came into being as a result of the recommendation of the National Joint Advisory Council (on which both the Trades Union Congress and the British Employers' Confederation are represented), that, in cases where the normal machinery for negotiation proved unsuccessful, during the period of national emergency, no strike or lock-out should take place but that the matter should be referred by the Minister of Labour to a National Arbitration Tribunal set up by himself. By a Defence Regulation Order embodying this recommendation strikes (and lock-outs) are forbidden unless the dispute has been notified to the Minister and he has not referred it to arbitration within twenty-one days. Unlike a decision of the Industrial Court or of an *ad hoc* arbitrator, the decision of the Tribunal is legally binding.

The effect of this Order is to make strikes illegal for, of course, the Minister always does refer a dispute that has been notified to him within the prescribed period; so that the strikes that have occurred have been "unofficial," i.e., they have not been called by the union but by a group of members acting on their own responsibility and in defiance of the union's authority. Last year it looked for a time as if there was going to be a first-class test case on this matter when the Confederation of Shipbuilding and Engineering Unions threatened to strike in support of their wage claims; but a ballot of the members of its constituent unions showed an overwhelming majority against strike action.

It would have been impossible for the legal restriction on strikes to have been maintained for so long if there had not been so large a majority of working people in favour of it—a support which was confirmed by a resolution passed at the meeting of the T.U.C. But there have been enough unofficial strikes—particularly in the mines, docks and transport industries—to give point to the question whether it is worth while to maintain a legal prohibition which can, apparently, be flouted with impunity. Until recently no attempt has been made to enforce the law and the fact that a group of unofficial strikers has no *locus standi* and no recognised officers with whom negotiations can be carried on, has made any settlement remarkably difficult to achieve. Nobody, in fact, knows quite what to do.

Last spring, for example, the Transport and General Workers' Union dismissed three of its members as a punishment for the part they had played in organising such a strike some time earlier. In protest, 14,000 dockers downed tools and paralysed the Port of London. The employers were not concerned in the dispute, which was entirely domestic to the union, and the Government evidently considered itself helpless to intervene, even going to the length of reprimanding Lord Ammon, Chairman of the National Dock Labour Board, who threatened disciplinary action if the men did not return to work.

During the years in which this restriction on strikes has been in force there has been only one occasion on which the strikers have been prosecuted and even that action was taken under authority of an old and generally disregarded Act, which gave the Government special powers over the workers in public utilities. During the summer, summons were issued against ten men, who had taken a leading part in a strike of 1400 maintenance men employed in certain gas-works. The strike caused a great deal of loss, annoyance and even suffering to thousands of London households but, probably, not more so than dozens of other strikes that have taken place during the last few years. Why the Government decided to take action in this one instance it is impossible to guess; but the men were duly prosecuted, sentenced to a month's imprisonment, given leave to appeal and ultimately fined £50 each, a sum which was immediately paid on their behalf by sympathisers who had collected the money against this probability.

Such an arbitrary choice of an occasion to wield the big stick does nothing to enhance the prestige of the Order and it seems likely that there will soon be a strong demand for a thorough revision of the position. The restriction on strikes was successful during the war and the years immediately following because the vast majority of workers were in favour of it and anxious to make it work reasonably well. The strikes which took place were an irritant, but not much more, and could be treated with considerable leniency without much after effect. But the general uneasiness which characterises the present situation is getting too marked for this condition to continue and there will probably be decreasing willingness to give up the unions' most powerful weapon. Recent experience has proved quite conclusively that compulsory arbitration cannot be imposed by authority upon unwilling disputants.

Technical Reports

Corona and Breakdown at Frequencies up to 12 Megacycles per Second (Ref. L/T229). By A. W. Bright, B.Sc. The British Electrical and Allied Industries Research Association. Price 12s., postage 3d.—The report begins with an account of previous work in the field of electrical breakdown in air at frequencies up to about 100 Mc/s. A series of experiments on the breakdown at h.f. of a concentric cylinder arrangement consisting of a thin wire inside a tube is then described. Using 20mm spheres, critical-gap phenomena have also been studied in air, nitrogen, freon and oxygen, and a simple theory is put forward to explain some of the results.

The Mechanical Properties of Dielectrics at High Temperatures (Ref. L/T242). By W. Lethersich. The British Electrical and Allied Industries Research Association. Price 4s. 6d., postage 3d.—The creep properties of dielectrics have been studied extensively at room temperatures and this report describes tests made at temperatures approaching the softening point. It was expected that there might be a change in the properties at these temperatures which would assist in devising a suitable test for plastic yield temperature. No such change was found and the creep properties resemble those at room temperature. The permissible applied stress is, of course, considerably less at high temperatures. The main feature is the absence of secondary creep, that is, of true viscous flow, even at temperatures at which the materials become rubber-like.

Naval Construction in 1950

By RAYMOND V. B. BLACKMAN

No. II—(*Continued from page 31, January 5th*)

DURING the past year there was no sign of the resumption of construction of the cruisers, "Blake," "Defence" and "Tiger," which were begun as long ago as 1941–42 by the Fairfield Shipbuilding and Engineering Company, Ltd., Govan, Scott's Shipbuilding and Engineering Company, Ltd., Greenock, and John Brown and Co., Ltd., Clydebank, respectively, and launched in 1944–45. The building of these vessels was stopped in 1946. It was officially stated in 1949 that constructional work on all three was suspended, but that work in relation to the preparation of equipment was being progressed. The contract for the "Defence" was cancelled and she is laid up in the Gareloch. The status of the "Blake," laid up at Greenock, and the "Tiger," laid up at Dalmuir, is officially "work suspended," and until early in 1950 the tentative date for their completion was fixed as 1951, but by mid-year this date had been abandoned and no new one scheduled.

As originally designed these ships were to have been similar to the cruiser "Superb," completed in 1945, with a displacement of 8000 tons, an armament of nine 6in guns, ten 4in A.A. weapons, eighteen 2-pounder pompoms, four 40mm A.A. guns, six 20mm A.A. pieces, and six 21in torpedo tubes; but it was officially stated in 1949 that the armament was under review and that the weapons and equipment to be fitted in these ships would depend on research then in progress. It is understood that the design, as recast, provides for an armament including four 6in guns, six 3in weapons and six 40mm A.A. pieces on a platform of 9550 tons standard displacement (11,700 tons full load). The dimensions are 538ft between perpendiculars with an overall length of 555½ft, a beam of 64ft and a draught of 21ft. Four Admiralty three-drum type boilers and a four-shaft arrangement of Parsons geared turbines aggregating 72,500 s.h.p. are to give a speed of 31·5 knots. The "Hawke" of this class, laid down at Portsmouth in 1944, was broken up on the stocks after the war, and the "Bellerophon" (ex-"Tiger"), a cruiser of enlarged design, ordered from Vickers-Armstrongs, was cancelled.

It may well be that before resuming the construction of the suspended cruisers of the "Tiger" class mentioned above, the Admiralty intends to await the results of experiments to be carried out in H.M.S. "Cumberland," 10,000 tons, the sole survivor in the Royal Navy of the old "County" class heavy cruisers (excluding the "Devonshire," converted to a cadets' training ship and largely demilitarised), which is being converted into Britain's first official trials cruiser earmarked and designed as such. She is being adapted for the testing of guided missiles, torpedoes and anti-aircraft guns, and is the first large ship to be so equipped. Fin stabilisers are being fitted to prevent rolling and to assist in accuracy of fire control, and lattice masts are being erected to support radar apparatus. She is scheduled to be ready for trials in 1951.

Modernisation plans envisaged for three of our six existing large fleet aircraft carriers to take the aircraft of the future were brought a step nearer to materialisation in 1950. The "Victorious," 23,000 tons, from the Training Squadron, entered Portsmouth Dockyard in March to prepare for modernisation, and in July the "Implacable," flagship of the Home Fleet, nominally of the same standard displacement, but actually nearer 26,000 tons, was also withdrawn into the naval yard at Portsmouth to prepare for similar modernisation which, I understand, involves stripping these carriers right down to the main deck and then almost completely reconstructing the ships over a period of three years. Their decks, lifts and arrester wires are to be strengthened. Catapults and more unorthodox methods of take-off may become normal, including vertical launching and flexible decks. But there was no sign of the carrier "Formidable," sister ship of the "Victorious," being taken in hand for the modernisation first mooted some two years ago and, since the end of 1949, she has been laid up on the Motherbank (normally the graveyard of ships awaiting disposal), off the Isle of Wight.

The "Indomitable," however, completed her extensive refit in Portsmouth Dockyard, though she was not ready by September as originally scheduled. She is still on trials at the time of writing and will join the Home Fleet in February. The "Indomitable" was dismantled forward and a new flight deck section was built on over the bows in place of the former curve down. The stern, bridges and other parts of the superstructure were also modified. All her electric cables were renewed, her internal operational spaces were improved, her flight deck was strengthened and an improved catapult fitted to enable her to operate much larger bombers than hitherto. Accommodation for an admiral and his staff was also fitted for future role as Flagship of the Commander-in-Chief. The aircraft carrier "Illustrious" was also withdrawn into dockyard at Devonport at the end of the year for extensive refit and substantial modernisation on similar lines to that of the "Indomitable." The remaining fleet aircraft carrier, the "Indefatigable," completed a refit in March, having been in Devonport Dockyard for nine months to be adapted as a training ship.

Four of our oldest, but largest, cruisers have also been or are being taken in hand for reconstruction and modernisation. They are the "Birmingham," "Glasgow," "Newcastle" and "Sheffield," completed in 1937. These ships have been redesigned with much less superstructure and lattice masts to provide a platform for the increased weight of radar apparatus which must necessarily be carried in a modern warship. The "Sheffield" is in an advanced stage of conversion at Chatham Dockyard and will be ready to join the Home Fleet in March. The "Birmingham," now in hand at the Royal Dockyard, Portsmouth, and the "Newcastle," at Devonport Naval Yard, will be completed in 1952. The "Glasgow" was taken in hand at Chatham at the end of 1950. All four ships displace 9100 tons (12,400 tons full load) and carry nine 6in guns, eight 4in A.A. guns, numerous smaller weapons and six 21in torpedo tubes at a speed of 32 knots. They will be equipped with all-electric galleys, bakeries and laundries, refrigerated stowage, and modern bathrooms.

Research

Research continued throughout the year into propelling machinery for naval ships. In April, 1950, it was announced that in view of the need for research in regard to future naval requirements, the Admiralty had placed a contract with Yarrow and Co., Ltd., to investigate, in association with the English Electric Company, Ltd., in what direction future propelling machinery designs for naval vessels should be developed. This investigation will cover a very wide field, including a world survey of existing design.

An investigation into the combustion of residual fuels in marine gas turbines is also included in research work sponsored by the Admiralty, which, as the Government department primarily concerned with the marine application of the gas turbine, has undertaken an extensive study of the heavy fuel problem in close collaboration with the National Gas Turbine Establishment. It has been recognised that it will be virtually essential to employ residual grades of fuel for gas turbines at sea. The equipment at present in use at the Admiralty Engineering Laboratory consists of a Metropolitan-Vickers "Gatric" engine similar to that installed in M.G.B. "2009" (now known as M.T.B. "5559") coupled to a "Dynamatic" brake, a pressurised combustion chamber testing rig and apparatus for the gravimetric chemical analysis of combustion gases.

Australia

Throughout 1950 constructional work proceeded on Australia's second light fleet aircraft carrier, the "Majestic," which is being built in Great Britain by Vickers-Armstrongs at Barrow, and which on transfer to the Royal Australian Navy will be renamed "Melbourne." Laid down on April 15, 1943, and launched on February 28, 1945, she was to have been completed and delivered to Australia in 1950, but owing to modifications in her design and constructional delays her delivery has been deferred. The tentative date for her contractors' sea trials to begin is now July, 1952, and she should be completed by the end of that year. She is a sister ship of H.M.A.S. "Sydney" (ex-"Terrible") delivered to Australia in 1949; of H.M.C.S. "Magnificent" in the Royal Canadian Navy, and of the "Hercules," "Leviathan" and "Powerful" described earlier under Great Britain.

There was also some unexpected delay in the completion of the destroyers built in Australia's own shipyards. H.M.A.S. "Tobruk," (Plate 4, January 5th) built by the Cockatoo Docks and Engineering Company, Pty., Ltd., was launched in December, 1947, and had been expected to be completed towards the end of 1949, but she was not finally accepted into service until May 8, 1950. She cost £2,470,000. Her sister ship, the "Anzac," was laid down in September, 1946, by Williamstown Naval Dockyard and launched in August, 1948. She began her sea trials in December, 1950, and will be commissioned in March, 1951, according to an official announcement recently made by the Minister for the Navy. She is estimated to cost £2,500,000 by the time she is completed, which is considerably more than the cost of the largest cruiser before the war.

These ships are the biggest destroyers yet built in the Commonwealth. They were constructed largely in accordance with designs prepared by the British Admiralty for "Battle" class fleet destroyers in the Royal Navy, but there are several alterations in secondary armament, sleeping accommodation for officers and men fore and aft, mess lay-out and other amenities. These ships have the first "Battle" type 4·5in guns and mountings of completely Australian manufacture. The weight of

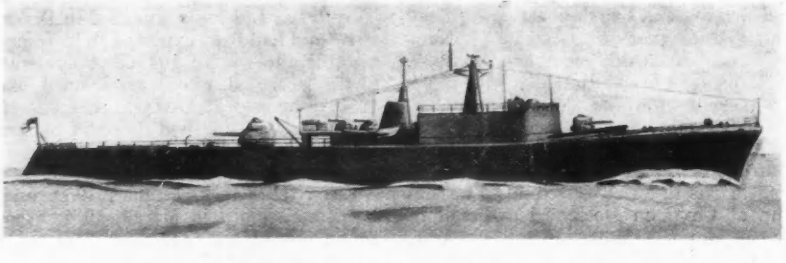
each twin turret is approximately 50 tons. The guns are reported to be fully automatic, firing a shell weighing 53 lb. The rate of fire is twenty-five rounds per minute with an accurate range of over 10 miles.

With no big gun amidships the design is similar to that of the earlier and not the later units of the "Battle" class in the Royal Navy. The "Tobruk" and "Anzac" have a standard displacement of 2325 tons (3200 tons full load), with a length between perpendiculars of 355ft, an overall length of 379ft, a beam of 41ft and a maximum draught of 13½ft. The armament comprises four 4·5in guns in twin turrets, both forward, with twelve 40mm A.A. weapons disposed in various positions from before the bridge to the quarter deck, and ten 21in torpedo tubes in two quintuple mountings before and after the "bandstand." They have a trellis foremast and a pole mainmast and a prominent square structure immediately abaft the single funnel. The propelling machinery consists of two Admiralty three-drum boilers and a two-shaft arrangement of Parsons geared turbines aggregating 50,000 s.h.p., designed for a speed of 35·75 knots, but the actual sea speed is about 31 knots obtained from 45,000 s.h.p.

While the above two "Battle" class units represent a fine Australian shipbuilding effort, being the fastest and most complicated warships ever built in the Dominion (though not the largest), four larger destroyers, with even more powerful propelling machinery, are being built in Australian yards, two by Williamstown Dockyard and two at Cockatoo Docks. Their design is similar to that of the "Daring" class under construction in Great Britain, described earlier. They will develop 54,000 s.h.p., equal to a designed speed of 34·75 knots and a sea speed of about 30·5 knots.

It was officially announced by the Naval Board in Australia in August, 1950, that six new fast anti-submarine frigates are to be laid down. Three are to be built by the Williamstown Naval Yard and the remaining three at Cockatoo Island Dockyard. Their displacement is reported to be about 2000 tons and their cost £12,000,000 for the six ships. They are expected to be of much the same design as the fast A.S. frigates projected for the Royal Navy.

But Australia will have fast A.S. frigates before the new vessels are completed. Her



ARTIST'S IMPRESSION OF NEW ANTI-SUBMARINE FRIGATE

five destroyers of the "Q" class, formerly of the Royal Navy, two of which were lent to the Royal Australian Navy in 1943 and the other three in 1945, were transferred permanently to Australia in June, 1950. All these ships are being converted to fast anti-submarine frigates similar to the "Relentless" and "Rocket" in the Royal Navy. Begun in 1940–41 and completed in 1942, the "Quadrant," "Quality," "Queenborough," "Quiberon" and "Quickmatch" originally had a standard displacement of 1705 tons (2425 tons full load), and developed 40,000 s.h.p., equal to a designed speed of 36·75 knots and a sea speed of 32 knots.

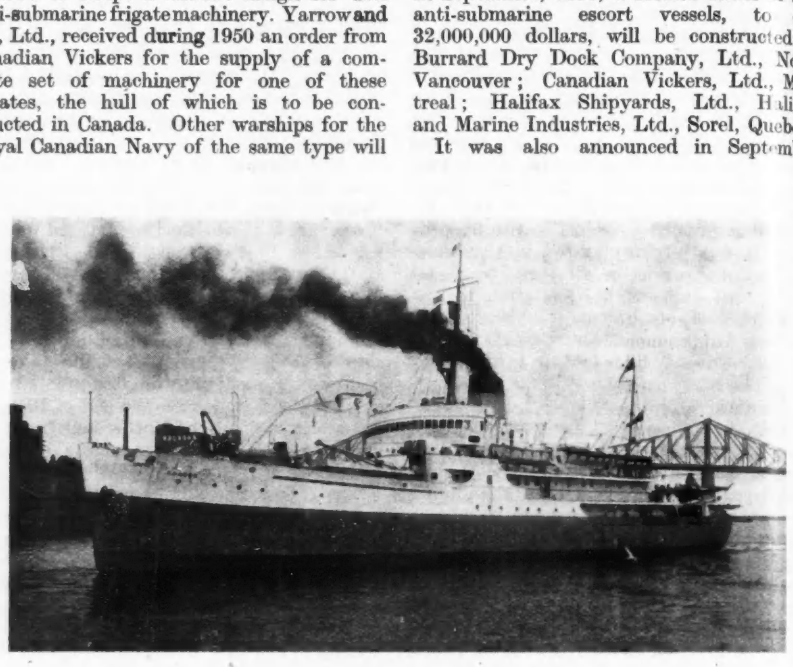
CANADA

The Canadian Government, which is building a certain number of warships, has decided to adapt a British design for fast anti-submarine frigate machinery. Yarrow and Co., Ltd., received during 1950 an order from Canadian Vickers for the supply of a complete set of machinery for one of these frigates, the hull of which is to be constructed in Canada. Other warships for the Royal Canadian Navy of the same type will be supplied with similar machinery to be built in Canada. The main turbines and condensers will be of English Electric design.

The construction of the first three high-speed anti-submarine escort vessels or frigates is under way in three shipyards, namely, Burrard Dry Dock Company, Ltd., North Vancouver; Canadian Vickers, Ltd., Montreal, and Halifax Shipyard, Ltd. The vessels are being built primarily for the detection and destruction of modern fast submarines and, in evolving their design, much assistance has been received from the Royal Navy and the United States Navy. In function the vessels will supersede the frigates and corvettes of the second World War, and like the corvettes their design has been worked out so that in the event of emergency they can be produced rapidly and in large numbers. In speed, manœuvrability and weapons the ships will fulfil all the requirements of their class for modern sea warfare. The design (illustrated herewith) provides for a flush deck, low bridge, considerable use of aluminium instead of steel for the superstructure and compartmented hull.

These new frigates will have a displacement of 2000 tons, an armament including two turrets with rapid-firing A.A. guns, and turbines developing a speed considerably in excess of 20 knots. They will carry 250 officers and men and will each cost 8,000,000 dollars. The first of the three ships is expected to undergo its trials in the summer of 1952. According to an official statement in September, 1950, a second batch of four anti-submarine escort vessels, to cost 32,000,000 dollars, will be constructed by Burrard Dry Dock Company, Ltd., North Vancouver; Canadian Vickers, Ltd., Montreal; Halifax Shipyards, Ltd., Halifax, and Marine Industries, Ltd., Sorel, Quebec.

It was also announced in September,



CANADIAN ARCTIC PATROL AND SUPPLY SHIP "C.D. HOWE"

1950, that ten "Influence" type minesweepers, valued at 9,250,000 dollars are to be constructed in Canada. They will be built extensively of aluminium, including frames and decks, with a displacement of 370 tons, a length of 105ft, and propelling machinery comprising a two-shaft arrangement of diesels. They are classified as motor sweepers with the designation "AMc."

The remaining four naval vessels of the new construction programme of eighteen ships for which contracts were awarded in September are gate vessels, to cost 2,000,000 dollars. The keel of a gate vessel to cost 25,000 dollars was laid down on May 16, 1950, by George T. Davis and Sons, Ltd., Lauzon, Quebec. With a length of 125ft and a.c. electric machinery, she will be a multi-purpose craft, capable of serving as gate vessel, fleet auxiliary, anti-submarine netlayer for entrances to defended harbours, and of being fitted for minesweeping.

The construction of a large icebreaker (Arctic Patrol Vessel) is under way at Marine Industries, Ltd., Sorel, Quebec. The design resembles that of the United States Coastguard "Wind" type. The vessel was laid down in November, 1949, and will be Canada's largest and most modern icebreaker. Completion is expected about 1952. The steel sides of her hull are about 2in thick and special heating tanks are being built into her. Another new detail will be a special flight deck built aft, which will accommodate a seaplane and will have space for a helicopter to land. The new vessel, designated "AGB 50," will have a displacement of 5400 tons, a length of 269ft, and diesel electric propelling machinery of 10,000 b.h.p., equal to a speed of 16 knots. It is expected that she will be armed with several short-range weapons.

In July, 1950, the "C. D. Howe," an Eastern Arctic Patrol vessel and supply ship (illustrated above) was completed by Davie

Shipyards at Lauzon. She is designed as a multi-purpose vessel, being icebreaker, meteorological and surveying vessel, hospital ship and potential fleet auxiliary for naval use in war, and has a standard displacement of 3628 tons (5125 tons full load), her dimensions being 276ft between perpendiculars with an overall length of 295ft, a beam of 50ft and a maximum draught of 18½ft. She has an economical speed of 12 knots and a radius of action of 10,000 miles with 50 per cent reserve of fuel. The capacity lift of the forward cranes is 30,000 lb. She has an icebreaker hull and is equipped with the latest Arctic navigational apparatus. Provision is made to carry a helicopter.

In addition to new construction Canada has refitted, rearmed and converted all eleven of her destroyers. The ships of the improved "Tribal" class—the "Athabaskan" (illustrated below), "Cayuga," "Haida," "Huron," "Iroquois," "Micmac," and "Nootka," 1927 tons displacement (2745 tons full load)—now each have a different armament. The "Crescent" and "Crusader," 1710 tons

CANADIAN "TRIBAL" CLASS DESTROYER "ATHABASKAN"

(2525 tons full load) have had their armament doubled, and the "Algonquin" and "Sioux," of similar displacement, have undergone extensive conversion. All these destroyers are now known as "DDEs," the Royal Canadian Navy having adopted a Hull Number Assignment List basically similar to that used in the U.S. Navy. According to the Canadian Chief of Naval Staff, all the destroyers have been equipped with the latest anti-submarine gear.

New Zealand

Approval has been given to build a surveying vessel in Great Britain for the Royal New Zealand Navy.

United States

On September 25, 1950, the new large fleet aircraft carrier "Oriskany," which had been expected to be completed at the end of 1949, was at last commissioned, bringing the number of aircraft carriers in the United States Navy up to 103. Nominally, she is the last of the twenty-four vessels of the "Essex" class, but in fact she is almost of a new design. Laid down at the New York Navy Yard on May 1, 1944, and launched on October 13, 1945, the construction of the "Oriskany" was delayed first by the end of the war and budgetary costs, and then to permit a recasting of her plans to embody new ideas. Recent developments made further alterations necessary, and changes were not fully incorporated until 1950. As finally completed she has been extensively modified to enable her to operate and to withstand the pounding of larger and heavier aircraft. Her catapults were built with the same idea in mind. She has a heavier flight deck and her elevators were constructed with a larger capacity than earlier "Essex" class carriers. She is the first aircraft carrier to use escalators to the flight deck. Blisters have been added to the hull to compensate for increased weight, and she has greater stowage for aviation spirit.

The "Oriskany" thus has many features, embodying changes made with an eye to the future, which will distinguish her from her half-sisters, including a smaller island superstructure, heavier handling gear, modern radar apparatus and new radio antennæ. She has a standard displacement of 30,800 tons and a full-load displacement of 37,000 tons, compared with the 27,100 tons (33,000 tons full load) of the earlier "Essex" class carriers. Her beam is listed as 129ft (whereas other ships of the type have a hull beam of 93ft) with an overall length of 888ft, an extreme width of 147ft, and a maximum draught of 30ft. Her armament, protection and aircraft capacity have also been modified. The propelling machinery consists of eight Babcock and Wilcox boilers supplying steam to geared turbines of 150,000 s.h.p. turning four screws and giving a speed of 33 knots.

Four more "Essex" class carriers, namely, the "Essex," "Kearsage," "Lake Champlain" and "Wasp" are being modified on similar lines to the "Oriskany," and it is planned to convert eight more in the near future.

It is reported that the Navy Department is planning to build a giant flush-decked aircraft carrier similar to the heavy carrier "United States" ("CVA 58"), the construction of which was stopped in 1949 and the material for which will probably be used in the construction. Work on the new carrier will not start until 1951. The design calls for a runway about 25ft longer than that provided in the largest existing aircraft carriers of the "Midway" class which have a displacement of 45,000 (55,000 tons full load), and an overall length of 968ft. It may be recalled that the "United States" was ordered on August 10, 1948, named on February 2, 1949, laid down at the Newport Company's Yard on April 19, 1949, and cancelled on April 23, 1949. She would have been the largest warship ever built in the world. The design provided for a standard displacement of 65,000 tons and a full-load displacement of 80,000 tons, with a water-line length of 1030ft, and an overall length of 1090ft, a water-line beam of 130ft, and a width of 190ft over fixed projections, capable of being increased to 236ft by means of retractable extensions. The propelling machinery was to have comprised sixteen boilers and geared turbines rated at 280,000 s.h.p., giving a speed of about 33 knots. She was to have taken four years to build and to have cost 189,000,000 dollars, or £67,500,000.

The missile-launching ship "Kentucky" was floated out from her building dock on January 20, 1950, to be laid up, and is being retained in her present condition for eventual completion if a future emergency arises. This ship has had a chequered building history. She was laid down at the Norfolk Yard on December 6, 1942, as a battleship of the "Iowa" class, and her conversion into a guided missile-launching ship was initiated in September, 1946, but was suspended in February, 1947. As a battleship she was 69·2 per cent complete and was built up to the main deck with propelling machinery installed, comprising twelve Babcock and Wilcox boilers and geared turbines of 200,000 s.h.p. from the Westinghouse Company on a four-shaft arrangement and designed for a speed of 33 knots. Her building had frequently been at a standstill. Construction seems to have been resumed merely to free the dry dock in which she was built. She is now moored at Norfolk. No work is being done on her. She may not be scrapped without the approval of Congress or the House Armed Services Committee. Her four sister ships, the "Iowa," "New Jersey," "Missouri" and "Wisconsin" were completed as 45,000-ton battleships in 1943–44.

The other large missile ship, the "Hawaii," is in similar state. She was laid down by the New York Shipbuilding Corporation on December 20, 1943, launched as a "large cruiser" (battle cruiser) on March 11, 1945, but suspended when 82·4 per cent complete, with her main battery in. Conversion to a guided missile ship was started in September, 1946, but stopped in February, 1947. She is now laid up at Philadelphia. This ship is also being preserved in good condition for completion if required in any future war, and she cannot be disposed of unless orders to that effect are given by the U.S. Government. No work is being done on her. Her two sisters, the "Alaska" and "Guam," were completed as 27,000-ton battle cruisers in 1944.

It was announced in 1950 that a heavy cruiser of the "Oregon City" class is to be converted into a guided missiles ship at a cost of 40,000,000 dollars, to be primarily used against aircraft. The Chief of Naval Operations stated that guided missiles are sufficiently advanced to be introduced into the Fleet as soon as possible. The three cruisers of the "Oregon City" class displace 13,700 tons (17,000 tons full load) and at present carry nine 8in guns, twelve 5in weapons, and fifty-two 40mm A.A. pieces at a speed of 33 knots obtained from eight Babcock and Wilcox boilers and General Electric geared turbines of 120,000 s.h.p., being protected by 6in sides and 3in to 2in decks. One of these ships should provide an adequate guided missiles platform since they are 673½ft long overall with a beam of 71ft and a maximum draught of 26ft.

Because the converted mercantile type of amphibious force flagships ("AGCs") are too slow for Fleet use what was to have been the fourth heavy cruiser of the "Oregon City" class is being reconstructed as a Task Fleet Command Ship. Built by Bethlehem Company, Quincy, Mass., this vessel, laid down on August 31, 1944, was originally "CA 125." When she was 56·2 per cent complete as a heavy cruiser she was cancelled on August 11, 1945, but she was reordered on July 1, 1948, and redesignated "CLC 1" with the new rating of Task Force Command Ship. She will constitute a completely new type of warship and will be named "Northampton." Her equipment and accommodation have been modified to suit the requirements of a headquarters vessel and flagship for an Admiral or

Commander-in-Chief and his staff and the necessarily more extensive communications apparatus. In the process her displacement is being increased to 17,000 tons. She will be armed with 6in or 5in guns and will be heavily armoured as might be expected for a ship of her function.

Another new type of warship, the completion of which, in 1951, is awaited with keen interest, is the "Norfolk," described as a "hunter-killer" ship with the designation of "CLK 1." She is described as an anti-submarine cruiser. She is certainly much larger than the large destroyers of the "Mitscher" class, and will cost 40,000,000 dollars. She was ordered on November 17, 1948, and is under construction at the Norfolk Navy Shipyard. On a displacement of 6000 tons she will have an overall length of 540ft. A sister ship, "CLK 2," to have been built by the Philadelphia Navy Shipyard, was deferred in 1949.

(To be continued)

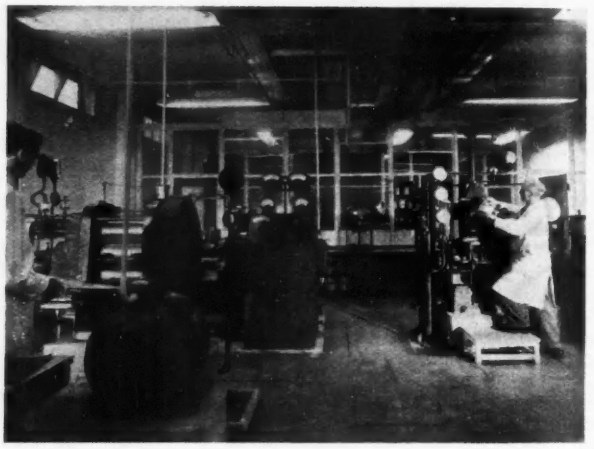
British Workshops in 1950

No. II—*(Continued from page 36, January 5th)*

Laboratories

IT is mainly upon research and development that the future prosperity of most industries depend, and the increasing interest shown in both pure and fundamental research in this country has been accompanied by a steady increase in the number of laboratories established during recent years at individual works and under the control of central bodies associated with particular industrial groups. Many such laboratories have, for reasons beyond their control, had to carry out their work under severe restrictions imposed by inadequate and unsuitable premises. It was therefore a matter of pleasure as well as of interest that we were able to record during 1950 that at least three central bodies moved into new and improved premises.

British Electricity Authority Laboratory, Leatherhead



Dunlop Plastics Research Laboratory

In our issue of July 28th last we described the new Leatherhead laboratories of the British Electricity Authority which have been equipped to complement the work of the E.R.A., manufacturing firms, the N.P.L., and of the B.E.A. power stations. It was pointed out that, although the older establishments served most of the requirements of the electrical industry for pure and applied research, the growth of the national grid emphasised the need for a central organisation to study the high-voltage transmission problems which were being met for the first time in this country. Working in co-operation with other research organisations to avoid duplicated effort, the new laboratory is engaged in solving the technical difficulties that arise in the electricity supply industry. In addition to long and short-term investigations, one of the main tasks undertaken is the examination and testing of materials and components submitted by the generating divisions of B.E.A. and electricity boards.

The original laboratory block of the British Non-Ferrous Metals Research Association in Euston Street, London, N.W.1, which were destroyed during the war, were reconstructed and reoccupied early in the year. In the rebuilding and re-equipment of this block opportunity was taken to provide for metal-working equipment which the Association had previously lacked.

New Scottish laboratories for the British Cast Iron Research Association were opened at Blantyre, Glasgow, and replaced the premises previously occupied—a 1300 square feet building at the rear of a school in Falkirk. The new premises consist of a 5000 square feet unit in one of the standard industrial estate blocks at Blantyre. This factory unit, by substantial internal alterations and additional building, was adapted to meet the special requirements of the laboratory. All departments of the new laboratory are well equipped and the spacious lay-out combined with excellent natural lighting and good ventilation provide excellent working conditions for the staff.

After many years of planning and delays occasioned by the war and building restrictions the Dunlop Rubber Company, Ltd., opened a large new research centre at Birmingham. This centre has been laid down to expand and correlate the research and development work in the laboratories of some thirty-one establishments within the Dunlop group at home and abroad.

For the new centre part of a large shadow factory was acquired and the administration block almost completely reconstructed to form the main laboratories, the power-house was adapted to form a pilot plant building and a new services building was erected. Of the 8-acre site reserved for the centre some 2 acres have been built upon, so there is considerable room left for future extensions.

The work done at the centre covers a very wide variety of activities, and its staff of 260 includes chemists, biologists, physicists, engineers, technicians and statisticians, all of whom, although working on different subjects, have their activities linked by regular consultation. Research is primarily concerned with chemical and physical problems, a study of the fundamentals of compounding, research in the application of textiles to rubber products, research into the design of products, and an intensive study into methods of accurately assessing performance under service conditions. A wide variety of interests is covered in the work of development of processes and products, and for convenience it is divided into chemical, colloid and physical studies at the centre. This work involves experimental, economic and commercial examination of new projects in order that the manufacturing divisions of the company can decide whether they are commercially attractive and on what scale manufacture should be carried out.

Each of the laboratories in the main building, which are concerned with research and development work, is well laid out and provided with a full range of services, including electricity, gas, hot and cold water, steam, compressed air, &c. The equipment used includes modern plant, machines and instruments, many of which are of the company's own design and are manufactured in the laboratory workshops.

The main area of the pilot plant building, which has a floor area of some 18,500 square feet, is used for the erection of prototype production units developed for testing new products or processes and adapting them for commercial use. The lay-out is planned to ensure a great deal of flexibility to permit the investigation of a wide variety of ever-changing problems.

As part of its post-war expansion Bakelite, Ltd., made provision for increasing the facilities available to its chemists, physicists and research engineers, and the erection and equipment of a new and modern laboratory was decided upon. The first part of this scheme came to fruition in June last, when a new laboratory and development building was opened at the company's Tyseley works. This stage represented about a third of the projected scheme and in it, research and development work, hitherto conducted in temporary buildings in various parts of Birmingham, is now concentrated under one roof on the works site. The new building is a two-storey structure, 125ft

long by 45ft wide, and it is divided off into a number of well-equipped laboratories and offices.

In its work of applied research the laboratory is responsible for the development to a manufacturing scale of all new products. The impetus for initiating the development of new types of plastics comes sometimes from within the department itself and sometimes in response to a demand for a material capable of meeting specific requirements for which existing products are unsuitable. An important aspect of the department's work is the development of new applications for the company's existing products, and, as synthetic resins are the basis of all these products, their development forms a major portion of the department's activities.

Oil Refineries in 1950

DURING the year which has just ended steady progress was made in the construction of new oil refineries in this country, and it is now evident that if the rate of construction is maintained the refining capacity of 20 million tons a year which the Government required for the oil industry will be attained in 1953.

In dealing with oil refineries in our annual reviews for 1949 we noted that the initial stage in the construction of the Shell refinery at Stanlow, near Ellesmere Port, in Cheshire, had been completed when the first distillation unit, with an annual capacity of a million tons, went into production. In May, 1950, the second stage was completed by the installation of a reforming unit. This reforming plant, by treatment of petrol obtained from straight distillation, enables larger quantities of finished petrol to be manufactured more economically whilst maintaining its quality. Another distillation plant with auxiliary equipment now being installed at Stanlow will permit a variation in output as between different kinds of products to comply with market demands. Units for the final treatment of the various products are also being installed. This refinery will, it is expected, be in full commission in 1952.

In addition to the new plant of the Shell Petroleum Company, Ltd., at Stanlow, a similar refinery is being built at Shell Haven, and in our issue of June 2nd last we reported progress on this plant and gave some details of the scheme. At Shell Haven a 600-acre site has been acquired by the company and no less than 250 acres are being actively developed. In November, six weeks ahead of schedule, the new plant at Shell Haven went into operation. Initially petrol and other oil products at a rate of 1,450,000 tons a year are being manufactured. Production is being at first confined to one distillation unit and ancillary plant, but by 1952 the refinery will be fully equipped and will have an output of over 2,000,000 tons a year.

This refinery at Shell Haven, a section of which is shown in one of the photographs reproduced in Plate 11, has, with the first distillation unit working, a designed intake of 6000 tons of crude oil per day. A doctoring plant at the refinery is designed to provide facilities for the treatment of 1300 tons per day of straight-run petrol from the distilling unit. In this treatment plant sulphur and mercaptans are removed from the petrol by mixing and settling with a doctor solution of lead oxide and caustic soda, and high-pressure air is used to regenerate the spirit. The first stage in the refinery construction programme included the installation of facilities for tetra-ethyl-lead blending of petrol to a desired octane value. Before the middle of this year a reforming unit will be in full operation at the refinery. This unit will process some 1200 tons per day of naphtha or light gas oil. It will be followed by a feed preparation plant with a designed daily capacity of 2500 tons of bitumen stock, which will be handled by the existing refinery at Shell Haven.

When the Stanlow and Shell Haven refineries are completed they will have a combined capacity of some 5 million tons a year and will have cost about £25 million. The two refineries operate mainly on crude oil brought by tankers from the Middle East, and, when finished, will be among the most complete and modern plants in Europe.

Good progress was made during the year on the work on the new refinery of the Anglo-American Oil Company, Ltd., at Fawley, and we are able to reproduce in Plate 11 photographs showing a part of this very large scheme. When completed next year, this plant will handle some 110,000 barrels of crude oil a day and produce about 5½ million tons of products a year.

The main plant units at this refinery will comprise two pipe stills, a catalytic cracking plant with light ends and polymerization facilities, Edeleanu plant (sulphur dioxide treating of kerosene and gas oil), other treating and sweetening plants for petrol and lubricating oil facilities. The catalytic cracking plant will use gas oil as feed stock and half its output will consist of about a million gallons of good-quality petrol a day.

For the construction of this refinery some 100,000 cubic feet of concrete will be used, and for this reason what is thought to be one of the largest concrete and aggregate plants in the world has been laid down on the site. This plant has an output of 140 cubic yards of concrete an hour and during September alone 6000 cubic yards of concrete were poured, bringing the total produced to that date to well over 52,000 cubic yards

The second and main phase in the construction of the plant embraces the installation of the main refinery units, and for this purpose four large guy derricks have been erected. The largest of these derricks is 265ft high with a boom 140ft long, and with its 100 h.p. motor it is capable of handling loads of up to 100 tons. A typical example of the units to be handled by these derricks is the debutanizer tower, 100ft high and weighing 135 tons, which arrived in one piece on the site. This tower, which forms one part of the catalytic cracking plant, had to be lifted into a vertical position by means of the derricks.

Also to be constructed in this second phase is a new marine terminal, 3200ft long with, berthing facilities for four ocean tankers. For this work piles have had to be driven across a stretch of marsh land to take a 5000ft long causeway for the approach and a new pipe band through which the incoming crude oil and outgoing finished products will pass.

During the year work was started on the site of a large new refinery for the Anglo-Iranian Oil Company on the Isle of Grain, in Kent. This refinery will, when complete, have an annual throughput capacity of 2 million tons of crude oil and its major plants will be brought into operation in four stages. It is planned to finish the first stage early in 1952 and put into operation a crude distillation unit, gasolene stabilisers and a copper chloride sweetening plant. In the second stage, to be completed by the end of the same year, there will be erected a vacuum distillation plant, propane deasphalting unit, furfural extraction unit, dewaxing unit, and a clay contact plant, together with a number of tanks for the manufacture and blending of lubricating oils. A vacuum flash unit, a catalytic cracker and washeries and treatment plants will be added in the third constructional stage in 1953. In the fourth stage various ancillary plant will be introduced for the production of special products and to improve further the quality of other products. In addition to the refinery itself, two new jetties will be built to accommodate tankers up to the largest sizes afloat.

The Grangemouth refinery of Scottish Oils, Ltd., is now being extended to handle some 1½ million tons a year. In the first stage of this extension scheme the plant installed will include a crude tapping unit, a phosphoric acid treating plant, and a copper chloride treating plant. Storage capacity will be considerably increased by the introduction of sixteen 144ft diameter, 30ft high, floating-roof tanks, and a new power station is being built. By the middle of next year, when the second stage of the project will be in operation, there will be put into service a catalytic cracking plant, a vacuum distillation unit to prepare feed stock, and a catalytic polymerisation plant for white spirit, as well as other plant for the manufacture of special products. All finished products from the extended refinery will be shipped by tankers from existing berths at the Grangemouth docks. Crude supplies will be brought to the plant by means of a pipe-line from a new jetty at Finnart, on Loch Long, on the West Coast of Scotland. This pipe-line of 12in diameter will be 60 miles long.

For the construction of the new plant at Grangemouth an interesting form of foundation has been adopted to overcome the difficulties caused by the depth of silty river mud which extends down to some 120ft over the site area. The "egg box" foundation, which is used, consists of a hollow concrete raft subdivided into compartments or cells. For this raft precast vertical panels are assembled into box forms on site by welding up the rein-forcing bar ends and grouting the joints. The earth is then excavated from the box compartments, which under their own weight sink down until the required depth is reached. Reinforced concrete bottoms are then cast *in situ* in the compartments and afterwards tops are added to make each an air-filled watertight cell.

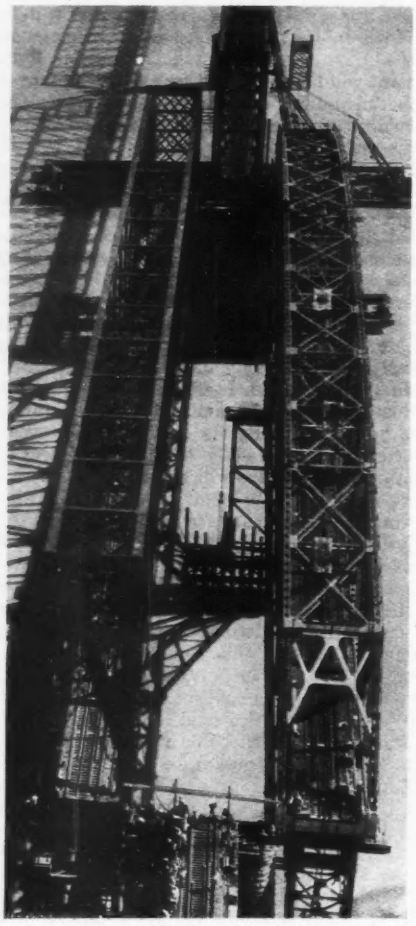
American Engineering News

(From our American Correspondent)

Replacement of a Bridge Span

An interesting reconstruction problem relating to a bridge of the Illinois Central Railroad over the Ohio River at Cairo, Illinois, has been solved successfully by engineers of the American Bridge Company, a subsidiary of the United States Steel Corporation. The existing bridge had been in service for sixty-one years: while the piers were still satisfactory, the need to carry faster and heavier trains called for a new superstructure. The

accompanying illustration shows the manner in which the span replacement proceeded, requiring only a twenty-hour stoppage of traffic. The spans illustrated are 518ft long; the original one, on the left, weighs 1000 tons, the other replacement span weighs 1600 tons. Temporary support units were erected on both the upstream and the downstream sides of the existing bridge. The replacement span was assembled on the downstream supports and made to rest on steel rollers to facilitate its eventual positioning. All tracks and auxiliary equipment were installed in advance. The upstream support unit was intended to act as a temporary pier structure



SPAN REPLACEMENT ON THE ILLINOIS CENTRAL RAILROAD BRIDGE

during the removal of the existing bridge span. Once all these preparations had been completed, a diesel barge anchored upstream was connected to the old span by means of cables and, subsequently, hauled the entire span a distance of 34ft onto the temporary upstream trestle. The barge was next connected to the new span, which was hauled into alignment with the adjoining tracks. Once in place, the new span was anchored and the tracks connected, so that train service could be resumed within twenty hours after the commencement of the replacement operation. After being stripped of its rails and ties, the old span was dumped into the river, to be cut up for scrap by wrecking and diving teams. Replacement of another 518ft span and several shorter ones within the bridge structure will proceed in a similar manner.

American Society of Mechanical Engineers

The seventy-first annual meeting of the American Society of Mechanical Engineers was held in New York during the week of November 27th. Attended by more than 7000 engineers, the meeting comprised eighty-three technical sessions, during which some 200 papers were presented. The scope of the meeting has been summed up as the development of power, the design of machines and the management of men for the exploitation of both. The technical fields covered by the various sessions ranged from applied mechanics to production engineering, from heat transfer to gas turbines, and from textile to wood industries. At the annual dinner of the convention, the Holley Medal was awarded to Charles G. Curtis, the inventor of the Curtis steam turbine, and honorary memberships in the Society were conferred, amongst others, on Oliver V. S. Bulleid, of Dublin; Dr. Lillian M. Gilbreth, of Montclair, New Jersey, and Dr. Frederick Ljungstrom, of Stockholm. The industrial economy of Great Britain was discussed at one of the A.S.M.E. luncheon sessions, when W. R. Woolrich, the dean of engineering of the Universty of Texas, fervently declared that Britain is in desperate need of a revival of personal religion to prevent the rapid growth of communistic fervour in its troubled youth! Having returned recently from a year's stay in the British Isles, Dean Woolrich commented: "Those of us who have lived and worked with the British, recognise and hold in very high regard their integrity, their 'stick-to-it-iveness,' their patriotic zeal, their individual abilities and their international statesmanship. In the scientific field they surpass the Americans in fundamental and basic investigation and research. The puzzle to most of them is, why Americans, who trail them in basic scientific attainment, so far outdistance them in the applied sciences and in technological productivity." Dealing with technical education, Dean Woolrich suggested that more British post-graduate students be placed in the universities of other leading nations of the world. He maintained that Britain had been too self-sufficient in her system of scientific education and now needs a new freshness of creative education. To-day, Norway, with its population of less than three million, has more university students in the United States than has Great Britain, with sixteen times as great a population.

Running concurrently with the Annual Meeting of the A.S.M.E., the 1950 National Power Show was held at the New York Grand Central Palace. More than 300 exhibits occupied the three floors of the Palace building, often consisting of actual production machinery and apparatus and otherwise simulating plant performance by means of scale models. It is of particular interest to note that this year marked the initial showing of a considerable number of British machine tool and instrument products. Among the machinery which was exhibited and which will, in future, be stocked in the United States, were shaping and milling machines made by B. Elliott and Co., Ltd., London, N.W., die-casting machines made by Die-Casting Machine Tools, Ltd., London, N.; automatic lathes made by Modern Machine Tools, Ltd., Coventry, and vertical milling machines and die stamping machines made by C. V. A. Jigs, Moulds and Tools, Ltd., Hove, Sussex. In the field of instruments, there were exhibited insulation and resistance testers of the Record Electrical Company, Ltd., Broadheath, Manchester, and precision timers made by Electronic Instruments, Ltd., Richmond, Surrey. An outstanding exhibit at this year's Power Show was the new range of magnetic-particle clutches and brakes developed by the Vickers Electric Division of Vickers, Inc., St. Louis 3, Missouri. Based on the magnetic fluid clutch principle, which originated at the National Bureau of Standards several years ago, the units shown utilise the linking action of ferro-magnetic particles in a magnetic field to transmit torque between driving and driven members. Marketed as "Magneclutches," the units have, so far, been designed for application in five classes of service: power clutches for slip service; on-off or torque clutches; torque-limiting clutches, designed to slip at pre-set torques; reversing clutches with high torque-to-inertia ratios, and brake units replacing the conventional friction brakes.

French Engineering News

(From our French Correspondent)

The severe coal shortage in France, which may grow worse following the decision by the miners to "go slow," is threatening the armament programme and the heavy industries. The government's aim, nevertheless, is to keep imports down and to this end experiments are being carried on to find ways and means of obtaining better results from the coal used and methods of using coal dust and waste more effectively.

The French railways are at present experimenting with a mixture of rich coal and coal dust in locomotive fireboxes.

* * *

Credits for the expansion and replacement of Gaz de France equipment have been reduced from £8,100,000 to £7,000,000 for 1950. This means that Gaz de France has had to abandon several projects which were to be carried out during the coming year. These plans included the installation of mains from Lorraine to Paris for the transport of gas, and extensions to the system would have resulted in easier transfer of gas from plants situated near, or in the northern coalfields to the large cities. This system of gas mains was considered essential because during very cold periods consumption increases to such an extent that the present mains system carries the load only with great difficulty.

The construction of an interconnection system in Normandy to feed the centre of France has also had to be abandoned. The centre has at present a number of gas-producing plants, most of which are very old. They are costly to run and the Gaz de France had hoped to close them down. They will now have to be kept on for at least another twelve months.

The credits made available will be used to modernise those gas-producing plants which are about to break down owing to age and use. There will be little new construction.

* * *

Important electrical construction work is going ahead in Madagascar. A new dam has been built at Antelomita and the generating plant will have to be enlarged in order to double production. Other dams have been planned, which will serve the double purpose of irrigating rice fields and at the same time serving new generating plants.

* * *

Construction is shortly to begin on a new dam, to be known as the Barrage de la Broquerie, situated on the Maronne River, 6km upstream from Argentat in the Corrèze. The hydraulic plant to be installed will have a capacity of 19,400kW and the scheme it is estimated will take three years to complete.

* * *

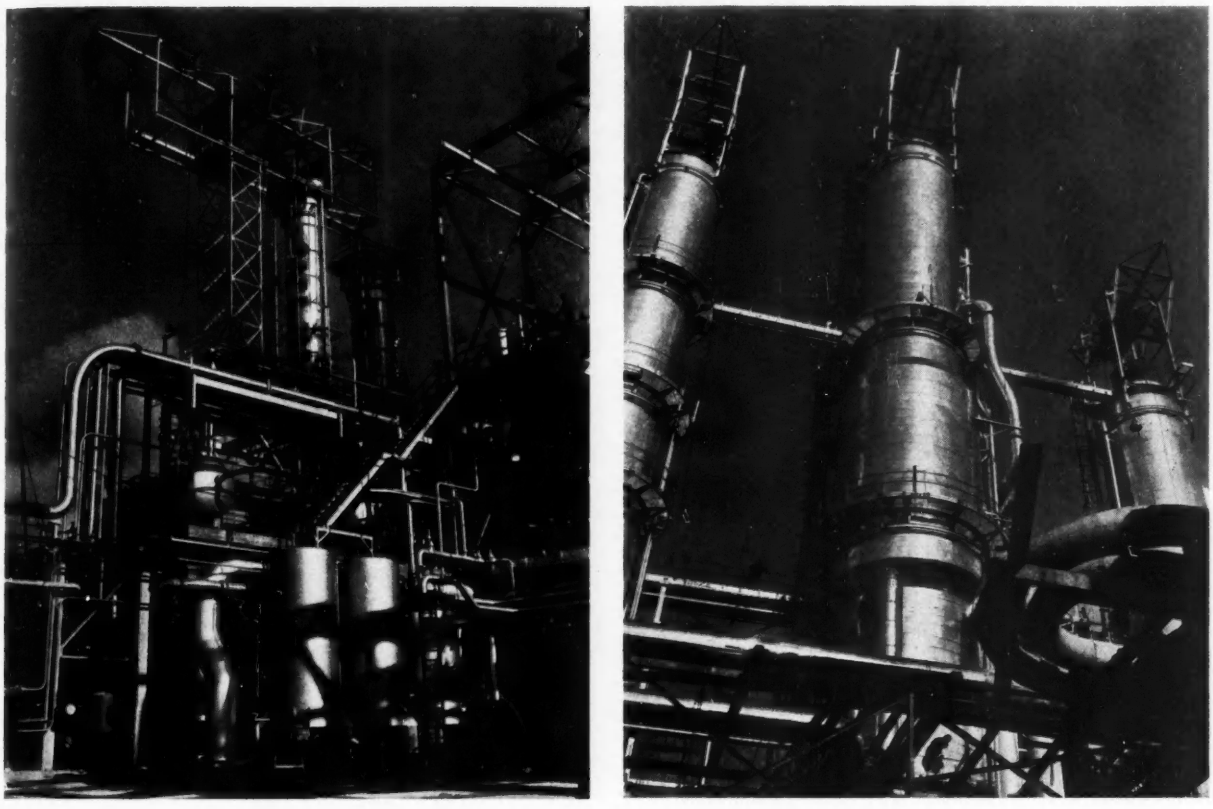
The plan to remove the Paris Central Market to the outskirts of the city has been abandoned. The authorities have accepted plans for modernising the market and installing new refrigeration plant. The plan to shift the market from the heart of Paris to the outskirts of the city was first mooted before the war. The argument that the area could be put to better purpose has, however, been dismissed and the familiar Halles will not be moved.

* * *

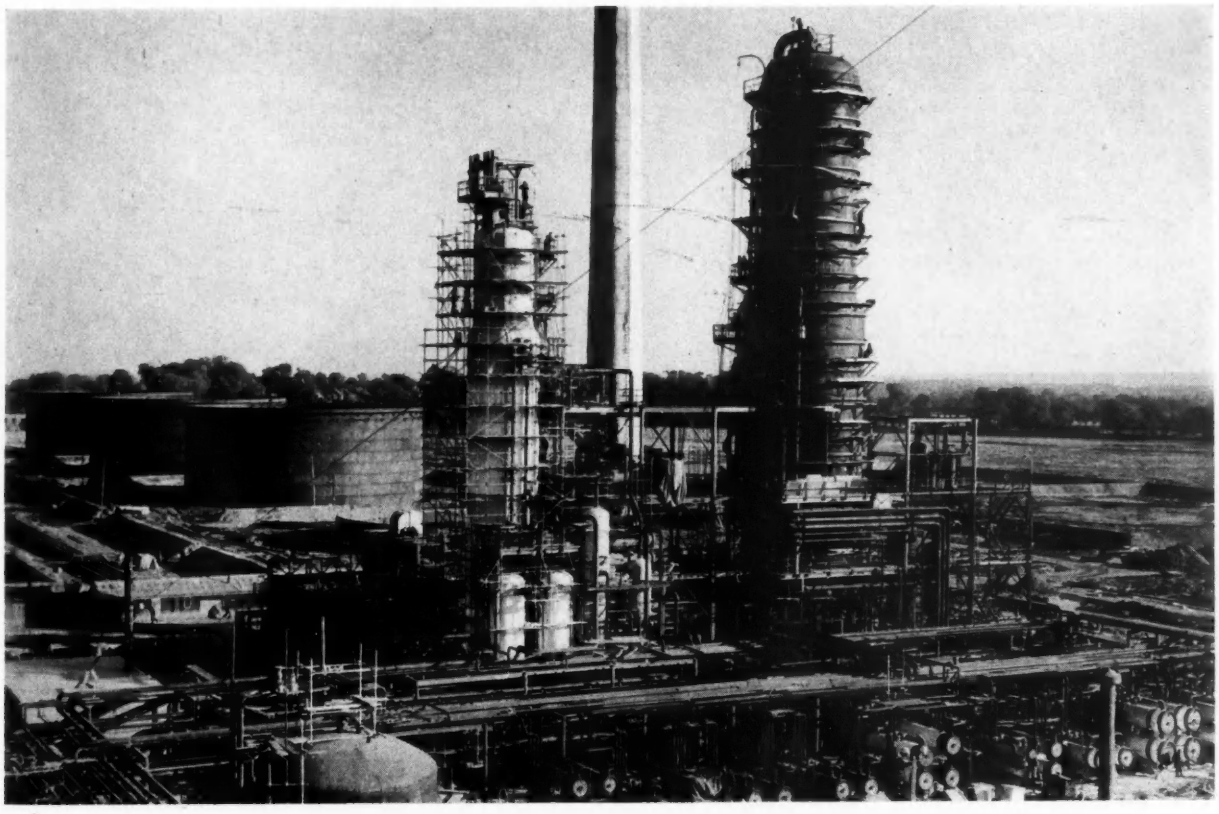
A new continuous hot rolling mill which went into production at Denain on December 27th, forms part of the great Usinor project. The first mill in the scheme, at Montataire, has been in production for some time.

The Denain plant has an annual capacity of some 800,000 tons of sheet metal, and it is expected that the combined production of Montataire and Denain will meet the entire demand for hot rolled steel. Although the total capacity of the plant is estimated at 1 million tons it has been decided to limit production to 800,000 tons of sheet varying in thickness from 1·5mm to 6mm. Montataire will take some 30,000 tons for re-rolling. During the first productive year—1951—the plant will produce only 400,000 tons, and peak production will be reached in 1952.

OIL REFINERIES IN 1950

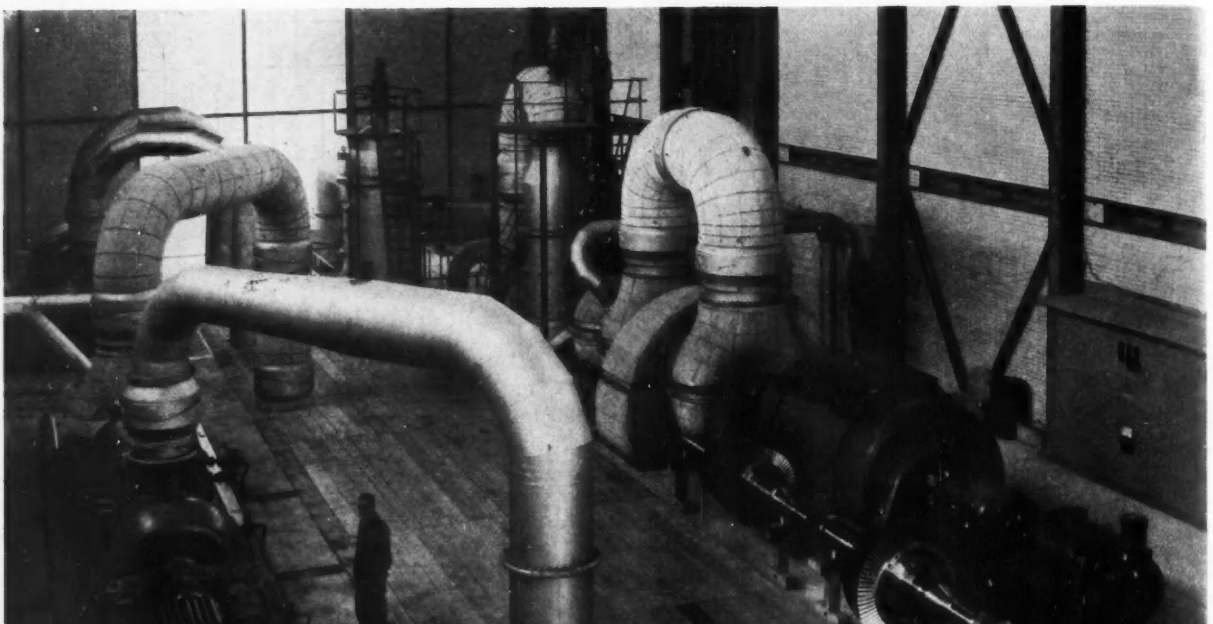


DISTILLATION PLANT AT SHELL HAVEN REFINERY

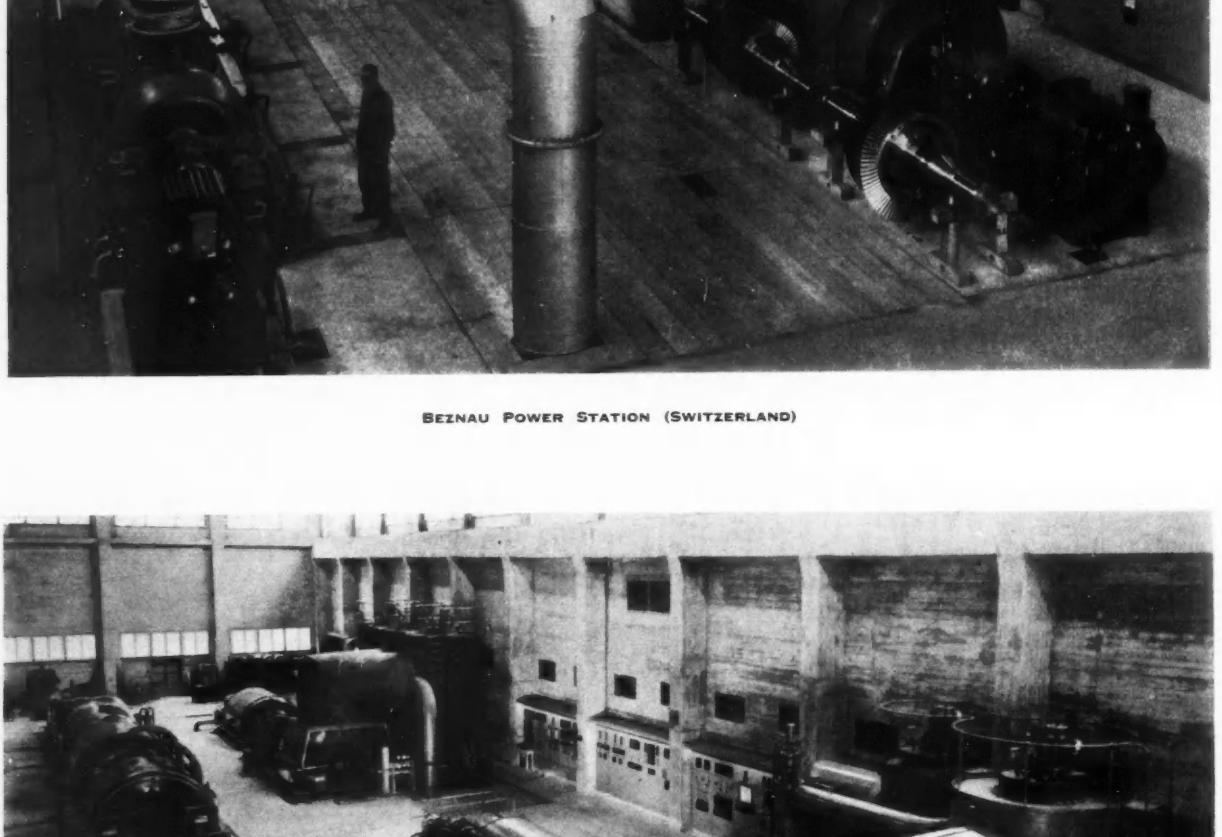


TWO-STAGE CRUDE OIL UNIT AT FAWLEY REFINERY

GAS TURBINES IN 1950



BEZNAU POWER STATION (SWITZERLAND)



WEINFELDEN POWER STATION (SWITZERLAND)

Industrial and Labour Notes

Coal Production

Figures relating to the coal production of Great Britain in 1950 were issued by the Ministry of Fuel and Power towards the end of last week. They show that output from the deep mines amounted to 204,116,000 tons, compared with 202,657,600 tons in 1949, and from opencast workings 12,185,000 tons, compared with 12,439,700 tons in 1949. Total production for last year was, therefore, 216,301,000 tons, as against 215,097,300 tons in 1949. It will be recalled that the Government's *Economic Survey* for 1950 suggested that the year's output of deep-mined coal might be between 205,000,000 and 210,000,000 tons, and of opencast, 12,000,000 tons. The amount of deep-mined coal lost during 1950 through recognised holidays, disputes and other causes is estimated at 10,292,900 tons, compared with 10,613,600 tons in 1949.

Final figures of consumption in 1950 are not yet known, but taking fifty-one weeks, up to December 23rd, inland consumption amounted to 198,553,000 tons, exports accounted for 12,936,000 tons, and bunkers took up 3,965,000 tons, giving a total of 215,454,000 tons, compared with 210,651,000 tons in the corresponding period of 1949. A more detailed analysis of the figures for the fifty-one weeks to December 23, 1950, shows that the coal requirements of public utility undertakings, coke ovens and industrial consumers amounted to 43,808,000 tons, compared with 42,147,000 tons in the corresponding period of 1949. In the week ended December 23, 1950, wage earners on colliery books numbered 688,100, of whom 285,000 were face workers, and total absenteeism in that week was 12·6 per cent, which was above the average for the year. Distributed coal stocks on December 23rd were 13,340,000 tons, compared with 15,271,000 tons a year earlier.

As recorded in these notes last week, the Prime Minister and other members of the Cabinet met the Executive of the National Union of Mineworkers on Wednesday, January 3rd, to discuss the immediate coal situation. At the meeting, a specific appeal was made to the miners to produce an extra 3,000,000 tons of coal by the end of April, with the maximum increase in the next two months. An official statement said that the Union Executive fully realised the seriousness of the situation and expressed its determination to co-operate fully in the achievement of the objective.

Railway Wages

The Court of Inquiry, set up by the Minister of Labour to investigate railway wages, began its sittings in public on Thursday of last week. The claims under discussion were put forward some months ago by the three railwaymen's unions, the National Union of Railwaymen asking for a wage increase of 10 per cent, the Railway Clerks' Association for an increase of 7½ per cent, and the Associated Society of Locomotive Engineers and Firemen for an increase of 15 per cent. All the claims have been rejected by the Railway Executive, which, however, made an offer of increases ranging from 1s. 6d. to 7s. a week if the unions would accept some reorganisation of present duties. The suggested reorganisation was designed to effect economies in railway working.

In supporting his union's claim before the Court, Mr. J. G. Baty, general secretary of the Associated Society of Locomotive Engineers and Firemen, asserted that the rates of wages paid to footplate men and cleaners were totally inadequate for the high responsibilities and tiring conditions of their work. He said that numbers of locomotive men were going into outside industries, where better remuneration could be obtained for less exacting and more congenial employment. The effect of adjustments made during the last ten years had been the progressive distortion of the wages structure. On Monday and Tuesday of this week the case for the railways was submitted by Mr. W. P. Allen, labour relations member of the Railway Executive, who pointed out that the serious financial situation of the railways justified the Executive's rejection of the wage claims. He contended that the present rates of wages and salaries were reasonably good and that the advantages attaching to railway employment added considerably to their value. During the wage negotiations, Mr. Allen said, he was told that the conditions which the Executive attached to its offer of increases represented a new technique. About that, he agreed, but, he claimed, a new technique was necessary if the railways were to increase productivity and keep pace with other industries.

Raw Material Difficulties

At a meeting of the London and South Eastern Regional Board for Industry on Wednesday of last week, the principal subject of discussion was the shortage of raw materials, particularly ferrous and non-ferrous metals. The Ministry of Supply reported that raw material shortages were "overshadowing the whole production picture."

The Board of Trade's report to the meeting said that there was a general impression of activity throughout the region, though difficulties were expected to increase as raw materials became shorter. The shortages were rapidly affecting exports, delivery dates were widening, and in many cases orders for raw materials were being refused even though suppliers were told that the materials were needed for exports to North America. In the main, it was stated, the smaller firms were suffering most, although shortages of non ferrous metals had already been reported by some of the bigger firms.

Another matter which was emphasised at the meeting was the importance of fuel economy and efficiency. Concern was expressed over the frequent electricity cuts, the view being advanced that industry was bearing the brunt of the load spreading and could do no more.

Index of Industrial Production

The index number of industrial production (1946=100), which is prepared by the Central Statistical Office of the Treasury, has been estimated provisionally at 150 for October, 1950, compared with 144 for September, 1950. Figures for the corresponding months of 1949 were October, 135, and September, 132. In issuing the October figure, the Central Statistical Office has stated that, taking the manufacturing industries only, the index number was 156, compared with 138 in October, 1949. On the basis of information so far received, the index number for all industries for the month of November is expected to be 151 or 152.

Productivity and Raw Material Shortages

The Chancellor of the Exchequer, Mr. Hugh Gaitskell, has contributed to the latest issue of the Government bulletin, *Target*, an article stressing the importance of increasing industrial productivity in spite of raw material shortages and fuel and power supply problems. The article acknowledges that raw material shortages will cause difficulty for a time, and that the switch to new forms of production as the result of the rearmament programme may mean readjustment difficulties for some firms.

The Chancellor emphasises that one means to greater efficiency is close co-operation and consultation between management and workpeople. In times of difficulty, he urges, "this is more necessary than ever, since opportunities for misunderstanding and friction grow greater when management and operatives are under strain as the result of shortages, power cuts and other frustrations." Another means of increasing efficiency, the article continues, is the avoidance of waste material and the use of a given quantity to the best possible effect. In waste saving and temporary substitution, it is suggested, there is usually room for a certain amount of ingenuity, and the Chancellor thinks that the present may be an excellent opportunity to make improvements and economies with valuable long-term effects. Where shortages and "hold-ups" exist, he observes, they are not likely to last very long, and schemes for improving productivity, worked out and discussed during the next few months, "can be applied in favourable conditions when they are ready."

Trade Unions and Production Methods

In connection with the Productivity Exhibition in Birmingham, there was a luncheon on Wednesday of last week at which one of the speakers was Mr. R. Openshaw, a member of the Council of the Amalgamated Engineering Union, and also of the General Council of the Trades Union Congress. Mr. Openshaw said that the T.U.C. looked upon scientific management as a logical development, and although there were instances of union opposition to new processes, they had usually occurred because those processes had been introduced in an unsatisfactory manner. Where trade union co-operation had been sought, the introduction of new schemes had been facilitated, with benefits to both sides.

Mr. Openshaw went on to say that techniques leading to improved industrial efficiency should be encouraged, and that the trade unions were prepared to assist their introduction provided they improved earnings and workshop conditions or promoted job security. The trade unions, Mr. Openshaw declared, were determined to find ways and means of increasing industrial output, but in so doing they expected employers to play their part and share the benefits with workers and consumers alike.

The Census of Production

The Board of Trade says that the scope of the Census of Production, to be taken in 1952, in respect of this year, and the information to be obtained, have now been settled after consultation with the advisory committee. All establishments coming within the field of production, including those engaged in building and contracting, will be included in the census.

The statutory return form will contain questions as to working proprietors, employment, wages and salaries, plant, machinery and vehicles, new building work, power equipment and fuel usage, shift working, materials and fuel purchased, work given out, stocks at the beginning and end of the year, output, and transport payments. Most of the questions will be framed in the same way as in the census taken in 1949, except that no quarterly wage figures—only the year's total—will be required. There will be no "analysis of sales" section, and no information about merchanted goods will be asked for. In the materials section only one value figure, namely, the total cost of materials and fuel purchased, will be required, though firms will be asked to state the quantities used of a limited number of selected materials about which information is specially needed.

Particulars about power equipment and fuel usage are to be collected in the census for the first time since 1930. The Board of Trade says that they will be of value in showing how far the use of power in industry has increased since 1930, and in making comparisons with other countries. Furthermore, the results should be of value for the study of productivity. In addition, it is stated, the census form will include a few questions about shift working.

Any firm wishing to have a list of the output or material headings, or other particulars about the 1951 census, is asked to write, stating its requirements and the nature of its business, to the Census of Production Office, Neville House, Page Street, London, S.W.1.

Notes and Memoranda

Air and Water

ADMIRALTY APPOINTMENTS.—The Department of the Engineer-in-Chief of the Fleet informs us that Captain (E.) A. B. Vickery, A.M.I.Mech.E., R.N., has relieved Captain (E.) L. F. Ingram, A.M.I.Mech.E., M.I.Mar.E., R.N., as Assistant Engineer-in-Chief (New Construction). Captain (E.) Ingram has assumed responsibility as Fleet Engineer Officer, Home Fleet.

SHIPBUILDING BROCHURE.—We have received from William Denny and Brothers, Ltd., an illustrated brochure giving an historical survey of the activities of the firm since it was founded in 1844. Landmarks in the first hundred years and many famous ships are mentioned, including the "Cutty Sark" and the "King Edward," the first turbine steamer in the world. Warships built during the second World War and the ships constructed in the post-war period are included in the record, and there are also given brief descriptions of the Leven Shipyard, the engine works and foundry, the experimental tank, and some notes upon the Denny-Brown ship stabiliser. The brochure contains many photographs of ships built by the firm, together with aerial views of the shipyard.

Miscellanea

BRITISH WORKSHOPS IN 1950.—In the first article on "British Workshops in 1950" in THE ENGINEER of January 5, 1951, we inadvertently referred to the new mechanised foundry of Ruston and Hornsby, Ltd., Lincoln as the Beeston Foundry. This establishment should, of course, have been referred to as the Beevor Foundry, the name which has been given to it to distinguish it from the other main foundries at Lincoln.

W. T. HENLEY FELLOWSHIP.—Dr. T. J. Lewis, B.Sc.(Eng.), Ph.D., has been elected to the W. T. Henley Fellowship, tenable at Queen Mary College, Mile End Road, London, E.1, for research work in electrical engineering.

THE LATE MR. A. C. LOW.—We have learned with regret of the death of Mr. Alexander Collie Low, C.B.E., which occurred in London on January 4th. Mr. Low was the secretary of the Engineering and Allied Employers' National Federation.

A SWEDISH LIMESTONE WORKS.—A new limestone works is to be built at Rättvik, Central Sweden, by the Stora Kopparbergs A.B. According to *The Anglo-Swedish Review*, the cost is estimated at about 4,000,000 kroner. Among other industries the products of the new works will feed the Domnarvet ironworks, which are situated nearby.

COPPER, LEAD AND ZINC.—The Ministry of Supply has announced that from Monday, January 8th, the prices at which copper, lead and zinc are sold (subject to licence) by the Ministry to consumers in the United Kingdom will be the prices ruling on the next working day after the consumer's order is posted, and not, as formerly, the day on which the order is posted.

SCIENTIFIC ADVISERS TO THE MINISTER OF FUEL.—The Minister of Fuel and Power has appointed the following to be members of the Scientific Advisory Council which was set up in 1948 to advise him on the scientific aspect of his statutory duties:—Professor Sir Cyril Hinshelwood, D.Sc., F.R.S., Sir Claude Gibb, F.R.S., M.I.Mech.E., and Colonel H. C. Smith. Dr. E. S. Grumell and Dr. H. Hollings have retired from the Council.

THE SOCIETY OF ENGINEERS' BESSEMER PREMIUM.—Mr. K. A. Zandstra, head of the high-frequency department of Philips Electrical, Ltd., has been awarded the Bessemer Premium by the Society of Engineers for his paper entitled "High-Frequency Heating in Industry." The presentation of the Bessemer Premium will take place on Monday, February 5th, on the occasion of the Society of Engineers' Presidential Address.

SCIENTIFIC GRANTS FOR N. IRELAND STUDENTS.—The Department of Scientific and Industrial Research states that grants of up to £600 a year are now available to science graduates in Northern Ireland who wish to devote the whole of their time to research. The grants, which take the form of senior research awards, are for a normal period of two years, and are tenable at any institution in Great Britain (or, in certain cases, abroad) approved by the Advisory Council. Applicants must show exceptional ability and they will compete with candidates from all parts of Great Britain. Details of senior research awards and the method of application for them are published in "Notes on Grants Awarded by Department of Scientific and Industrial Research to Research Workers and Students," February, 1950 (H.M. Stationery Office).

PLASTICS EXHIBITION AND CONVENTION.—A British Plastics Exhibition and Convention are to be held at Olympia, London, from June 6th to 16th next. More than sixty firms will be showing their products, and the exhibition will include a special feature of public interest entitled "The Story of Plastics," which is being designed to demonstrate the chief properties and applications of plastics. The papers to be presented at the Convention will cover many aspects of work and research in the plastics industry. The Exhibition and Convention are being organised by *British Plastics*, Dorset House, Stamford Street, London, S.E.1, with the co-operation of the British Plastics Federation.

AN ALUMINIUM DEGREASER.—We are informed by Jenolite, Ltd., that it will shortly be marketing a new aluminium degreaser and cleaner, which has been specially developed to clean and degrease aircraft wings and bodies, both inside and outside, as well as fuselages and cowlings. This new chemical, it is claimed, will in no way attack an aluminium surface. It is supplied in powder form and must be diluted at a ratio of 1 lb of powder to 1 gallon of water. It can be applied cold by ordinary distemper brush or articles may be dipped into a bath containing the solution, warmed to a temperature not exceeding 50 deg. Cent. This degreaser is guaranteed non-inflammable, non-caustic and non-injurious to rubber. The makers say that it has good wetting qualities and is efficient in cleaning the surface of greasy and dirty aluminium in a very short space of time. Samples of the new degreaser can be obtained from the company at 5, New Bridge Street, Ludgate Circus, E.C.4 (tel., City 4815, ext. 30).

WHITAKER'S ALMANACK, 1951.—The eighty-third annual edition of "Whitaker" has recently been published. Like its predecessors, it contains a wealth of information that is as useful as it is interesting. It is noteworthy that this, the 1951, edition is the largest yet printed, containing 1156 pages, compared with the 367 pages required for the first volume in 1869. It is appropriate to recall that the Almanack was established by Joseph Whitaker to give "an account of the astronomical and other phenomena and a vast amount of information respecting the Government, finances, population, commerce and statistics of the various nations of the world." The new edition accurately fulfils that function, and engineers, in common with other sections of the community, will find it, as usual, a valuable work of reference. It is published by J. Whitaker and Sons, Ltd., 13, Bedford Square, London, W.C.1, at 12s. 6d. net in the complete edition, or 25s. in the "library edition," which is half-bound in leather and contains coloured maps.

Launches and Trial Trips

BERENICE, motor tanker; built by Chantier et Ateliers de Saint Nazaire Penhoët for Compagnie Auxiliare de Navigation; length between perpendiculars 188·70m, breadth moulded 25·90m, depth moulded 14·15m, deadweight 31,300 tons; two Burmeister and Wain two-stroke, single-acting diesel engines, eight cylinders, 740mm diameter by 1400mm stroke, 6780 b.h.p. at 121 r.p.m. Launch, November 11th.

RYGJA, motor tanker; built by the Netherlands Dock and Shipbuilding Company for J. Ludwig Mowinckel's Rederi, Bergen; length between perpendiculars 151m, breadth moulded 20·65m, depth moulded 11·11m, deadweight 16,000 tons; Stork diesel engine, six cylinders, 5500 b.h.p. at 116 r.p.m. Launch, December 16th.

BINTA, motor tanker; built by Harland and Wolff, Ltd., for Mr. Per Gjerding, Bergen; length between perpendiculars 460ft, breadth moulded 59ft, depth moulded 34ft 10in, deadweight 12,000 tons; Harland-Burmeister and Wain single-acting, four-stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke, two single-ended multi-tubular boilers, steam auxiliaries. Trial, December 19th.

LE SIMOUN, motor trawler; built by Chantiers et Ateliers Augustin Normand for M.M. Cameleyre Frères; length between perpendiculars 32m, breadth moulded 7m, depth moulded 4·05m; M.A.N. single-acting, four-stroke, diesel engine, six cylinders, 450 b.h.p. at 207 r.p.m. Launch, December 27th.

REGENT CARIBOU, motor tanker; built by the Blythswood Shipbuilding Company, Ltd., for the Bowring Steamship Company, Ltd.; length between perpendiculars 516ft, breadth moulded 70ft 6in, depth moulded 38ft, deadweight 17,500 tons; Rowan-Doxford two-stroke oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5600 b.h.p. Launch, December 28th.

Personal and Business

MR. W. G. ASKEW, A.I.M., has been appointed to the staff of George Kent, Ltd., Luton, Beds, as technical journalist.

MR. JOHN DOUGLAS has been appointed joint managing director of Redfern's Rubber Works, Ltd., Hyde, Cheshire.

MR. F. PEARCE has been appointed executive director of Kirk and Co. (Tubes), Ltd., 74-82, Paradise Street, London, S.E.16.

MR. BRUCE WOODHOUSE has been appointed press officer of the Machine Tool Trades' Association, Victoria House, Southampton Row, W.C.1.

HOPKINSONS, Ltd., Huddersfield, announces the retirement of Mr. C. J. Hofton, for many years Midlands representative. Mr. J. H. Field has been appointed to succeed him.

MR. J. K. CLARK, B.Eng., A.M.I.Mech.E., has been appointed chief engineer of the Electro Chemical Engineering Company, Ltd., 161, Queens Road, Weybridge, Surrey.

MR. F. A. KIMBERLEY, managing director of the James Cycle Company, Ltd., Greet, Birmingham, has been elected president of the British Cycle and Motor Cycle Manufacturers' and Traders' Union.

COLONEL S. M. CAIRNS has been appointed managing director, and Mr. W. Hynard and Mr. J. P. Wesson have been appointed special directors, of Robert Boby, Ltd., Bury St. Edmunds. Major-General C. A. L. Dunphie has relinquished his office of managing director on taking up another appointment in the Vickers group.

THE NEW LONDON ELECTRON WORKS, Ltd., announces that Mr. Felix L. Levy, who has for many years served on the board, has been elected chairman and managing director of the company in succession to his father, the late Mr. Lawrence Levy. Mr. W. Clarke, general manager of the New London Electron Works, Ltd., since 1943, has been elected a director.

BRUSH BAGNALL TRACTION, Ltd., is the title of a new company formed to further the diesel-electric locomotive sales of the Brush-A.B.O.E. group and its associate, W. G. Bagnall, Ltd. The executive offices of the new company are at Falcon Works, Loughborough. Mr. A. P. Good is the chairman, the Hon. A. C. Geddes managing director, and Mr. P. J. Martin sales manager.

MR. F. MAY, Mr. L. Halpin and Mr. John H. Osborn have been appointed local directors of Samuel Osborn and Co., Ltd., Sheffield. Mr. E. Pasley and Mr. H. Dakin have been elected directors of the Titanic Steel Company, Ltd., and Mr. W. T. Hill has been elected a director of the Osborn Foundry and Engineering Company, Ltd., both of which companies are subsidiaries of Samuel Osborn and Co., Ltd.

THE BRITISH ALUMINIUM COMPANY, Ltd., Salisbury House, London Wall, E.C.2, announces the following changes of designation and appointments:—Mr. G. W. Lacey is now known as director in charge of sales, and Mr. R. G. H. Linzee as director in charge of establishment; Mr. G. A. Anderson has become general sales manager, and Mr. H. H. Cundell, home sales manager; Mr. P. J. Ferguson has been appointed export sales manager, and Mr. M. J. J. Richards has succeeded Mr. Ferguson as manager of the Scottish branch office.

Books of Reference

The British Catalogue of Plastics, 1950. London: The National Trade Press, Ltd., Drury House, Russell Street, W.C.2. Price 50s. net.—The new edition of this reference work has been revised and brought up to date in the light of recent developments in the plastics industry. Its first section deals with the applications and uses of plastics in a wide range of industries and for all purposes. This section is followed by chapters on materials, including the choice of plastics, an encyclopedia of plastics materials, and tables giving their properties. A comprehensive section on processes gives much useful information on mould design and construction, moulding inserts, compression moulding; transfer moulding, injection moulding, extrusions, laminating, plastic fabrication, and the various other processes involved in fabricating and finishing plastics. A wide range of the machines and equipment used in the industry is also described in some detail. The book concludes with a useful buyers' guide and subject index. Many excellent photographs are reproduced with the text matter, which also includes numerous tables and relevant data sheets.

British Patent Specifications

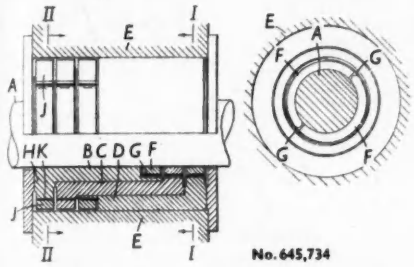
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

RAILWAY ENGINEERING

645,734. September 13, 1948.—IMPROVEMENTS IN AND RELATING TO BEARINGS FOR ROTATING SHAFTS, Arthur Ronald Trist, 906, McClure Street, Victoria, British Columbia, Canada.

In the drawing a side elevation of a bearing according to this invention is given with part sectional elevations on *I-I* and *II-II*. The shaft *A* has three bushes, *B*, *C* and *D* interposed between it and the bearing or plummer block *E*. The right-hand end of the bush *B* has a recess in which are two semicircular shoes *F*, each of which is mounted on one end of a thin, curved, flat spring *G* attached at its other end to the bush. The left-hand end of the bush *B* is provided with a flange *H* within two semi-circular shoes *J*, each of which is mounted on one end of a thin flat spring *K* attached at its other end to the periphery of the flange. The springs *G* lightly press the shoes *F* against the shaft *A* when the shaft is stationary. The springs *K*



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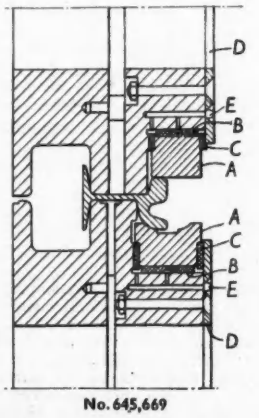
press the shoes *J* lightly against the periphery of the flange *H* when the bush *B* is stationary. The other bushes are arranged somewhat similarly to the bush *B* with two spring-controlled shoes. The springs *G* are so gauged that the shoes *F* cease to transmit motion to the bush *B* when rotating at a speed of about 1730 r.p.m. and if for any reason the speed of rotation of the bush *B* exceeds this value, the rotation is checked by the shoes *J*. When operating, all the shoes co-operate lightly with their complementary surfaces either directly or through a film of lubricant when the bushes *B*, *C* and *D* and the shaft *A* are rotating at the prescribed speeds. If the speed of any bush falls below that prescribed then the pressure of its shoes against the driving surface is increased and if the speed of any bush exceeds that prescribed then the pressure of its checking shoes against the more slowly moving or stationary surface is increased.—*November* 8, 1950.

645,669. October 13, 1948.—STRAIGHTENING RAILS AND ROLLERS THEREFOR, Acieries Reunies de Burbacheich-Dudelange Societe Anonyme, Avenue de la Liberte, Luxembourg.

This straightening gear is designed to engage opposite sides of the head of the rail as well as the web by appropriate parts of the straightening rollers,



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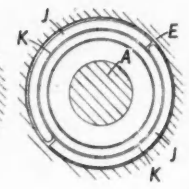
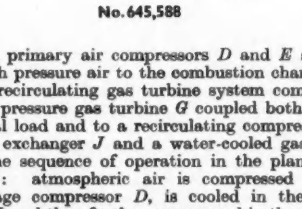
in such a manner that the linear speed of the rail engaging parts of the rollers is substantially identical. This effect is obtained, as shown in the drawing, by mounting annular rings *A* on journal bearing rings *B* and engaging their annular faces with thrust bearing rings *C*, held by plates *D*, secured by bolts in the appropriate straightening rollers. Lubricators *E* are provided in the rollers. It will be seen from the drawing that the annular rings are readily detachable so that the rings *A* can be changed according to the type of rail. By providing the relatively rotatable annular rings as described, the combined rollers cause the head of the rail to follow exactly the deflections of the web during straightening of the rail as it is fed through the rollers and the linear speed of the annular rings is the same as the peripheral parts of the rollers engaging the web. The straightening pressure is reduced to a normal force and the tangential force on the work is reduced to a minimum. Thus, not only is the straightening of the rails effected accurately but the major cause of breakages of rails is eliminated.—*November* 8, 1950.

MISCELLANEOUS

645,588. October 13, 1948.—IMPROVEMENTS IN OR RELATING TO GAS TURBINE POWER PLANTS, Karl Baumann, of Fairgreen, Clamhunger Lane, Mere, Knutsford, and Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1-3, St. Paul's Churchyard, London, E.C.4.

Gas turbines operating on the simple open-cycle system suffer from the disadvantage that in order to keep the temperature of the gas and metals within permissible limits, the amount of air required for a given output is much more than is necessary for complete combustion. This results in large chimney losses, since even by using a heat exchanger the gases can only be cooled down to a temperature of about 300 deg. Fah. An object of this invention is to provide gas turbine plant which will reduce or overcome the foregoing disadvantage and in which the amount of air required need not be appreciably more than is needed to support combustion. Referring to the drawing, the plant consists of two systems, an open-cycle gas turbine system in which the high pressure gas turbine *A* is coupled to the external load, with intermediate pressure and low pressure gas turbines *B* and *C*





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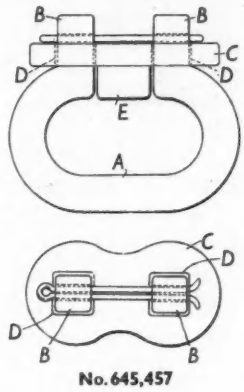
driving primary air compressors *D* and *E* supplying high pressure air to the combustion chamber *F* and a recirculating gas turbine system comprising a high pressure gas turbine *G* coupled both to the external load and to a recirculating compressor *H*, a heat exchanger *J* and a water-cooled gas-cooler *K*. The sequence of operation in the plant is as follows: atmospheric air is compressed in the first-stage compressor *D*, is cooled in the intercooler *L* and then further compressed in the second-stage compressor *E*. From the compressor *E* the highly compressed air is conducted to the combustion chamber *F* via the heat exchanger *M*, in which it gains heat from the gases exhausted from the turbine *C* before they are discharged to atmosphere. Fuel is injected into the combustion chamber and combustion takes place at high pressure. From the combustion chamber a proportion of the combustion gases, at a suitable temperature controlled by the mixing of recirculated gas, is conducted to the high pressure gas turbine *A* and, after expansion, is further expanded in the intermediate and low pressure turbines before being discharged to atmosphere after cooling in the heat exchanger. From the outlet of the combustion chamber a proportion of the gases is directed to and expanded in the high pressure gas turbine *G* in the recirculating system; the gases then pass, after expansion, through the heat exchanger *J* to the gas cleaner *N*. From the cleaner the gases pass to the cooler *K* before recompression in the compressor *H* to a pressure slightly higher than that obtaining in the combustion chamber. From the compressor *H* the gases pass through the heat exchanger *J* in which they are heated to a suitable temperature by the hot gases exhausted by the turbine *G*. The recirculated gases are then mixed with the hot combustion gases to control the gas temperature.—*November* 1, 1950.

645,457. May 27, 1948.—LINK FOR THE TEMPORARY REPAIR OF CHAINS, Edward Tomkinson, of 38, Westwood Crescent, Winton, Eccles, near Manchester, and George Moxon (Engineers), Ltd., Grieg House, 66, Wilkinson Street, Sheffield, 10.

This invention relates to a link for the temporary repair of heavy chains, such as those of dragline excavators, which cannot readily be removed for permanent repair. The drawings show one form of link. The device comprises a C-shaped member *A*



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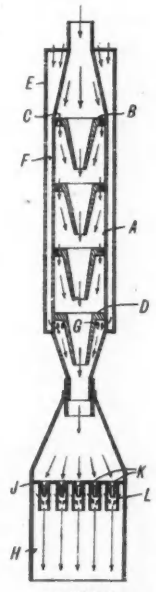
with the two free ends *B* spaced apart and extended at right angles to the longitudinal axis of the link. When the links of the fractured chain have been connected by the main member, a closure plate *C* having suitably shaped and spaced holes *D* is slid over the free ends and secured in place by a split pin or the like, which is passed through holes in the two ends *B*. The closure member *C* may, if desired, be provided with a lug *E* projecting into the gap between the two free ends of the link in the assembled position.—*November* 1, 1950.

INTERNAL COMBUSTION ENGINES

646,384. July 22, 1947.—NEW OR IMPROVED EXHAUST SILENCER FOR INTERNAL COMBUSTION ENGINES, Ellis Smith, of Vulcan Works, Randall Well Street, Bradford.

At the inner or full diameter end of the tapered inlet portion of the silencer casing *A* is a transverse plate or baffle *B* with a central coned portion extending in the direction of the outlet and terminating in an orifice. In the plate between the



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larger diameter or inlet end of the coned portion and the wall of the casing is a ring of openings *C*, each or some of which are formed as Venturi tubes or passages. There are second and third plates with nozzles of increasing diameter. Exhaust gases entering the silencer expand in part in the central cone of the plates *B* and in part through the openings or Venturi passages *C* surrounding the cone. The gases then pass to the second, third

and fourth coned plates, where the action is repeated the gases then passing to the outlet. The final plate *D* has no surrounding Venturi passages. The casing *A* is surrounded as shown, by a tube *E* of such diameter as to present between itself and the casing an annular passageway *F*, the inlet end of which is closed by a perforated plate. The outer end of the tube *E* is closed and adjacent this closed end the casing *A* is provided with a ring of holes. Air entering through the perforations of the plate at the top of *E* passes along the space between the tube and the casing and becomes heated. The final cone acts as an injector to draw the heated air along the annular passage. The outlet end of the silencer is provided with a flattened member *H* of fish-tailed form, in which is a plate *J* having spaced holes or passages *K* extending parallel to the longitudinal axis of the silencer. Each of the passages is surrounded by a short tube *L* having orifices through which air is drawn by the action of the gases flowing out through the passages *K*.—*November* 22, 1950.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Association of Supervising Electrical Engineers

Mon., Jan. 15*th*.—CENTRAL LONDON BRANCH: St. Ermin's Hotel, London, S.W.1, "A Camera and the Engineer," G. E. Whalley, 6.50 p.m.——STOCKPORT BRANCH: White Lion Hotel, Underbank, Stockport, "Electric Traction," Mr. Kennerley, 8 p.m.
Tues., Jan. 16*th*.—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "Electrical Machinery for the Movement of Materials," H. S. Carnegie, 6.30 p.m.
Wed., Jan. 17*th*.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Electronics," J. E Fielden, 7.30 p.m.
Sat., Jan. 20*th*.—OXFORD BRANCH: Southern Electricity Board's Demonstration Room, George Street, Oxford, lecture by J. L. Taylor, 3 p.m.

British Institution of Radio Engineers

Wed., Jan. 17*th*.—S. MIDLANDS SECTION: Public Library, Rugby, "Ultrasonic Generators for High Powers," B. E. Noltingk, 7 p.m.

Chemical Society

Thurs., Jan. 18*th*.—Burlington House, Piccadilly, London, W.1, "Structure and Enzymatic Breakdown of Proteins," K. Linderstrom-Lang, 7.30 p.m.

Diesel Engine Users Association

Thurs., Jan. 18*th*.—Caxton Hall, Westminster, S.W.1, "Developments in Thames Tugs," F. J. Mayor, 2.30 p.m.

Illuminating Engineering Society

Tues., Jan. 16*th*.—LIVERPOOL CENTRE: Electricity Board's Service Centre, Whitechapel, Liverpool, 1, "Light, Colour and the Stage," E. Faraday, 6 p.m.
Wed., Jan. 17*th*.—Royal Institution, Albemarle Street, London, W.1, "The Early Years of Illuminating Engineering in Great Britain," J. W. T. Walsh, 6 p.m.——TEES-SIDE GROUP: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Decorative Lighting," L. H. Hubble.
Thurs., Jan. 18*th*.—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, High Street, Cheltenham, "Lighting of Architecture," G. Grenfell Baines, 6.30 p.m.

Incorporated Plant Engineers

Tues., Jan. 16*th*.—GLASGOW BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, "The Work of the Department of Scientific and Industrial Research," H. Buckley, 7 p.m.

Institute of British Foundrymen

Sat., Jan. 13*th*.—E. MIDLANDS BRANCH: School of Arts and Crafts, Green Lane, Derby, "Grey Ironfoundry Productivity Team's Report," 6 p.m.——LANCASHIRE BRANCH: Engineers' Club, Albert Square, Manchester, "Foundry Management To-day," J. Stott, 3 p.m.——SCOTTISH BRANCH: Technical College, George Street, Glasgow, "The Production of Intricate Castings from a Durable Loam Mould," 3 p.m.

Institute of Fuel

Tues., Jan. 16*th*.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "The Transport and Storage of Coal," Lionel Locket, 5.30 p.m.

Institute of Industrial Supervisors

Tues., Jan. 16*th*.—KIDDERMINSTER SECTION: Carpet Trades, Ltd., Mill Street, Kidderminster, industrial film show, "Steel" and "Chain Making," 7.30 p.m.
Thurs., Jan. 18*th*.—LEEDS SECTION: Great Northern Hotel, Leeds, annual general meeting, 7.30 p.m.——WARRINGTON SECTION: White Hart Hotel, Sankey Street, Warrington, annual general meeting, 7 p.m.——COVENTRY SECTION: Geisha Cafe, Hertford Street, Coventry, "Productivity in the American Pressed Metal Industry," J. M. Phillips, 7.30 p.m.

Institute of Marine Engineers

Wed., Jan. 17*th*.—Technical College, East Ham, "Welding in Ship Repair Work," J. W. Coulthard, 7 p.m.
Fri., Jan. 19*th*.—Technical Institute, Falmouth. "Launching of Ships," R. S. Hogg, 7.30 p.m.

Institute of Metals

Tues., Jan. 16*th*.—S. WALES LOCAL SECTION: University College, Metallurgical Department, Singleton Park, Swansea, "Recent Developments in the Production of Some of the Rarer Metals," A. R. Powell, 6.30 p.m.

Institute of Navigation

Fri., Jan. 19*th*.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Submarine Navigation," P. G. Satow, 5 p.m.

Institute of Petroleum

Wed., Jan. 17*th*.—STANLOW BRANCH: Grosvenor Hotel, Chester, annual general meeting, 7.15 p.m.

Institute of Road Transport Engineers

To-day, Jan. 12*th*.—S. WALES GROUP: S. Wales Institute of Engineers, Cardiff, "Welding in Vehicle Maintenance and Repair," G. Mackenzie Junner, 7 p.m.
Mon., Jan. 15*th*.—SCOTTISH CENTRE: North British Hotel, Edinburgh, "The Manufacture and Performance of Brake Linings," J. G. Remington, 7.30 p.m.
Tues., Jan. 16*th*.—WESTERN GROUP: Grand Hotel, Bristol, "Recent Developments in Rear Axles," T. R. Beady, 7.30 p.m.
Thurs., Jan. 18*th*.—Royal Society of Arts, John Adam Street, London, W.C.2, "Trends in Design, with Particular Reference to the Commercial Show, 1950," P. M. A. Thomas, 6.30 p.m.——N.E. CENTRE: Hotel Metropole, Leeds, "Brakes and Clutches," Ivan M. Waller, 7 p.m.

Institution of Chemical Engineers

Sat., Jan. 13*th*.—MIDLAND BRANCH: The University, Edmund Street, Birmingham, "Applicability of Vapour-Liquid Equilibria to Extractive Distillation," F. H. Garner, 3 p.m.

Institution of Civil Engineers

Tues., Jan. 16*th*.—Great George Street, Westminster, S.W.1, "Concepts of Safety in Structural Engineering," A. G. Pugsley, 5.30 p.m.
Thurs., Jan. 18*th*.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, "Repairs to Reinforced Concrete Wharves on the Tees and Tyne," A. C. Kirk, 6.30 p.m.

Institution of Electrical Engineers

Sat., Jan. 13*th*.—N. MIDLAND STUDENTS' SECTION Yorkshire Electricity Board Offices, Whitehall Road, Leeds, 1, Main Centre Chairman's Address, W. F. Smith, 2.30 p.m.
Mon., Jan. 15*th*.—Savoy Place, Victoria Embankment, W.C.2, discussion on "Aesthetic Design in Transmission and Distribution Systems, including the Power Station," opened by A. R. Cooper, 5.30 p.m.——N.E. CENTRE: King's College, Newcastle-upon-Tyne, "Operation and Maintenance of Television Outside Broadcast Equipment," T. H. Bridgewater, 6.15 p.m.
Tues., Jan. 16*th*.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2, "The Measurement of Interlaminar Resistance of Varnish-Insulated Silicon-Steel Sheet for Large Electrical Machines," E. D. Taylor; "Relaxation Methods Applied to the Problem of A.C. Magnetisation of Ferromagnetic Lamina," O. I. Butler and M. R. Sarma, 5.30 p.m.——S. MIDLAND CENTRE: Town Hall, Birmingham, "Illumination," L. J. Davies, 6 p.m.
Wed., Jan. 17*th*.—EDUCATION DISCUSSION CIRCLE: Savoy Place, Victoria Embankment, W.C.2, discussion on "Electric Wave Filters," opened by F. E. Rogers, 6 p.m.
Thurs., Jan. 18*th*.—UTILISATION SECTION: Savoy Place, Victoria Embankment, W.C.2, "Electrically Interlocked Guards on Machines," W. Fordham Cooper, 5.30 p.m.

Institution of Heating and Ventilating Engineers

Tues., Jan. 16*th*.—S.W. BRANCH: G.E.C. Building, Cathays Park, Cardiff, "Brains Trust," 6.30 p.m.
Wed., Jan. 17*th*.—LONDON AND DISTRICT ASSOCIATE MEMBERS' AND GRADUATES' SECTION: 178–180, Edgware Road, W.2, "Costing for the Heating Engineer," L. Forni, 6.30 p.m.

Institution of Locomotive Engineers

Wed., Jan. 17*th*.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Standardisation of Coaching Stock," S. G. Smith, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 12*th*.—Storey's Gate, St. James's Park, S.W.1, "Water Hammer in a Pumping Main and its Prevention," A. M. Binnie and D. G. Thackrah; "The Automatic Hydraulic Ram," J. Krol, 5.30 p.m.——SCOTTISH BRANCH: North British Station Hotel, Edinburgh, "The Supercharging of Internal-Combustion Engines," Sir Harry R. Ricardo, 7 p.m.
Mon., Jan. 15*th*.—MIDLAND BRANCH GRADUATES' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Mechanical Engineers' Responsibility in Raising Productivity," B. E. Stokes, 7 p.m.——N.E. BRANCH: Neville Hall, Westgate Road, Newcastle-upon-Tyne, annual general meeting, "Naval Gearing — War Experience and Present Development," 6 p.m.——DERBY A.D. CENTRE: Midland Hotel, Derby, "The Use of Wire-Resistance Strain Gauges in Automobile Engineering," J. R. Bristow, P. Metcalf and C. H. G. Mills, 7 p.m.——SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "An Experimental Investigation into Pre-ignition in the Spark-Ignition Engine," D. Downs and J. H. Pignéguy, 7.30 p.m.
Wed., Jan. 17*th*.—N.E. A.D. CENTRE: University Chemistry Lecture Theatre, Leeds, "Wear of Fuel Injection Equipment and Filtration of Fuel for Compression-Ignition Engines," A. E. W. Austen and B. E. Goodridge, 7.30 p.m.
Thurs., Jan. 18*th*.—E. MIDLANDS BRANCH, PROVISIONAL GRADUATES' SECTION: School of Art, Green Lane, Derby, "The Effect of Competition on Design and Industry," S. C. H. Davis, 7 p.m.——N.W. BRANCH: Engineers' Club, Albert Square, Manchester, "Form Grinding by Mechanical and Optical Methods," E. A. Cooke, 6.45 p.m.——SCOTTISH BRANCH GRADUATES' SECTION: Royal Technical College, Glasgow, "Vibration Phenomena," Duncan Morrison, 6.30 p.m.——WESTERN A.D. CENTRE: Royal Hotel, Bristol, "Automobile Test Rigs," L. H. Dawtrey, 6.45 p.m.
Fri., Jan. 19*th*.—Royal Naval Engineering College, Manadon, Plymouth, "Naval Gearing—War Experience and Present Development," J. H. Joughin, 6 p.m.

Institution of Mining and Metallurgy

Thurs., Jan. 18*th*.—Geological Society, Burlington House, W.1, "Method for the Preparation of High-Purity Indium Metal," T. A. A. Quarm; "Factors Affecting Reduction of Zinc Oxide by Carbon," and "Study of Reduction of Zinc Metaferrite by Carbon," D. W. Hopkins and A. G. Adlington; "Detection of Columbite by Ultra-violet Light," R. A. Mackay, 5 p.m.

Institution of Structural Engineers

Wed., Jan. 17*th*.—NORTHERN COUNTIES BRANCH: Neville Hall, Newcastle, "The Aesthetics of Structural Engineering," 6.30 p.m.——YORKSHIRE BRANCH: Great Northern Hotel, Leeds, "Welded Highway Bridges," D. J. Davies, 6.30 p.m.
Fri., Jan. 19*th*.—WALES AND MONMOUTHSHIRE BRANCH: County Buildings, Colwyn Bay, "Soil Mechanics," D. J. Maclean, 6 p.m.

Institution of Works Managers

To-day, Jan. 12*th*.—MANCHESTER BRANCH: Grand Hotel, Manchester, "Disabled Persons in Industry," Sir Frederick J. West, 6.30 p.m.
Tues., Jan. 16*th*.—LEICESTER BRANCH: Bull's Head, Loughborough, "Management and Productivity," J. Ayres, 7 p.m.——W. YORKSHIRE BRANCH: Royal Hotel, Brighouse, "Managing a Small Factory," A. H. Huckle, 7.30 p.m.

Junior Institution of Engineers

To-day, Jan. 12*th*.—39, Victoria Street, London, S.W.1, "Soil Testing and its Application to Foundation Problems," S. J. Button, 6.30 p.m.
Fri., Jan. 19*th*.—39, Victoria Street, London, S.W.1, "Some Notes on Diesel Locomotives for Mines," A. O. Ellison, 6.30 p.m.

Manchester Association of Engineers

Fri., Jan. 19*th*.—Engineers' Club, Albert Square, Manchester, "Electrical Aspects of the Manchester-Sheffield Electrification Scheme," A. G. Hopkins; "The Mechanical Design and Construction of the Manchester-Sheffield-Wath Electrification Scheme," H. O. Hincheliffe, 6.45 p.m.

North East Coast Institution of Engineers and Shipbuilders

To-day, Jan. 12*th*.—Mining Institute, Newcastle-upon-Tyne, "Combustion Problems of Gas Turbines," I. Lubbock, 6.15 p.m.

Royal Aeronautical Society

Wed., Jan. 17*th*.—PRESTON BRANCH: Technical College, Corporation Street, Preston, "Recent Developments in Aircraft Materials," H. Sutton, 7.30 p.m.

Royal Institution of Chartered Surveyors

Tues., Jan. 16*th*.—12, Great George Street, Westminster, S.W.1, annual conference of agricultural members.

Royal Society of Arts

Wed., Jan. 17*th*.—John Adam Street, London, W.C.2, "1851–1951: A Century of British Industry," The Right Hon. Lord McGowan, 2.30 p.m.

Royal Statistical Society

Wed., Jan. 17*th*.—N.E. GROUP: Newcastle Chemical Industries Club, 18, Lovain Place, Newcastle-upon-Tyne, "Statistics and Industrial Health," H. Campbell, 6.30 p.m.

Societe des Ingenieurs Civils de France

Wed., Jan. 17*th*.—Institution of Civil Engineers, Great George Street, Westminster, S.W.1, "The Rocks Between France and England," R. C. S. Walters, 5.30 p.m.

Society of Chemical Industry

Tues., Jan. 16*th*.—Burlington House, Piccadilly, London, W.1, "The Application of High-Speed Centrifuges in the Chemical and Process Industries," R. H. Dolton.

Stephenson Locomotive Society

To-day, Jan. 12*th*.—N.W. AREA: Geographical Society, Deansgate, Manchester, "The G.C.R. and its Predecessors," Geo. Dow, 6.30 p.m.
Fri., Jan. 19*th*.—LIVERPOOL CENTRE: Central Station Offices, Liverpool, "Churchward—the Master Engineer," W. A. Tuplin, 7 p.m.

LECTURES ON MAGNETIC MATERIALS.—A course of six lectures on "Magnetic Materials" is to be given by Mr. A. E. De Barr, F.Inst.P., at the Northampton Polytechnic, St. John Street, London, E.C.1, on Wednesday evenings at 7 p.m., beginning January 31st. The object of the course is to give an account of the theory and practice of modern magnetic materials, their properties, methods of preparation and application. The materials to be considered include the magnetically soft alloys, such as nickel irons and silicon irons, materials specially developed for use at high frequencies, such as powder cores and ferrites, and permanent magnet alloys. The fee for the course is £1.